

**APPENDIX F**

**ECONOMICS**



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#### **LIMITED REEVALUATION REPORT SUPPLEMENT TO GENERAL DESIGN MEMORANDUM BALTIMORE HARBOR AND CHANNELS 42-FOOT PROJECT**

##### **INTRODUCTION**

The purpose of this appendix is to present the economic rationale used to identify benefits associated with widening the Brewerton Channel Eastern Extension beyond its current width of 450-feet. This appendix will: (1) discuss background of the current project together with the current project's relationship to other deep draft navigation studies being conducted by the Philadelphia District and the Baltimore District, Corps of Engineers (much of the information developed during these studies provided the basis for the analysis of widening the Brewerton Channel Eastern Extension); (2) discuss the methodology used to identify the "without project" condition and the alternative "with project" conditions; and (3) discuss the benefits to accrue from widening of the Brewerton Channel Eastern Extension and a presentation of benefits and costs.

##### **BACKGROUND**

The existing project for Baltimore Harbor was adopted by the River and Harbor Act of 8 August 1917, and modified by the River and Harbor Acts of 21 January 1927, 3 July 1930, 2 March 1945, 3 July 1958, and 31 December 1970.

The River and Harbor Act of 3 July 1958 authorized the deepening of the main approach channels to Baltimore Harbor from 39 feet to 42 feet and the deepening and widening of the connecting channels to the Chesapeake and Delaware (C&D) Canal from 27 feet to 35 feet deep and from 400 feet to 600 feet wide. The connecting channels are comprised of the Brewerton Channel Eastern Extension, Swan Point Channel, and Tolchester Channel. In addition, the project authorized maintenance of a 39-foot depth in the Northwest Branch, providing that local interests first deepen the channels to that depth. All of the improvements authorized by the 1958 Act have been constructed with the exception of widening the western five miles of the Brewerton Channel Eastern Extension from 450 feet to 600 feet. The Brewerton Channel Eastern Extension is located in the northern portion of the Chesapeake Bay, Maryland, and extends from the mouth of the Patapsco River in an east-southeasterly direction across the Chesapeake Bay, as shown in Figure 1.

No work was accomplished to deepen or widen the Brewerton Channel Eastern Extension from its existing dimensions of 27 feet deep and 400 feet wide through 1984 since the State of Maryland was unable to provide suitable placement areas for the dredged material. On 18

January 1982, the channel was reclassified from the "active" to the "deferred" category by the Office of the Chief of Engineers.

The Maryland Port Administration (MPA) in a 14 January 1985 letter to the Baltimore District, Corps of Engineers designated the Hart-Miller Island (HMI) containment facility for the deposition of the dredged material from the Brewerton Channel Eastern Extension and requested reactivation of the channel project. The channel was reclassified from the "deferred" to the "active" category on 15 May 1985. Several alternatives were formulated to determine the best plan for deepening and widening the channel. Construction of the channel to the authorized width was determined to be economically justified and approved by HQUSACE in March 1986. However, a channel 35 feet deep and 450 feet wide was constructed based on an analysis of existing and future vessel passing situations, the pilot's vessel operating procedures, and the safe operation of the previous 400-foot wide Connecting Channel and 450-foot wide channels through the C&D Canal. The State of Maryland's 14 May 1986 letter acknowledged the constraints of the 450-foot wide channel. A contract for dredging the Brewerton Channel Eastern Extension to a depth of 35 feet and width of 450 feet was awarded in July 1986 and was completed in December 1986, at a cost of \$8.6 million with the removal of 4.0 million cubic yards (mcy). Subsequently, the unconstructed 150-foot width was reclassified to the "deferred" category.

The turn at the eastern end of the channel was widened in FY 1988. The eastern mile of the channel was widened from 450 feet to 600 feet and the turn at the eastern end was widened an additional 400 feet in FY 1990-1991 during maintenance dredging operations to provide additional safety for the navigation of larger ships. The Maryland Port Administration (MPA) has requested that the channel be widened to its authorized width of 600 feet. The plan considers widening the existing channel to allow safer and more efficient navigation of vessels calling on the Port of Baltimore.

## **CURRENT ENVIRONMENT**

The purpose of this study is to assess the economic impact of modifications to the Brewerton Extension, as they relate to the Baltimore Harbor System. The Brewerton Extension is an important link for vessels traversing the C&D Canal into and out of the Baltimore Harbor. As the level of traffic becomes more significant, and usage increases, the need for a more easily traversed Extension is imperative. The objective is to determine that set of channel dimensions that is both economical and most beneficial.

In February, 1994, the Industrial and Systems Engineering (INSE) Program at the University of Memphis was asked to be a partner in the study of the Baltimore Harbor Anchorages and Branch Channels, under the leadership of the Baltimore District Corps of Engineers (BCOE). The defined purpose of the study was to investigate the economic viability of anchorage and branch channel modifications in the Baltimore Harbor system. This study has been completed

recently. A related study by the Philadelphia Corps of Engineers involved a model of operations in the C&D Canal. The purpose was to identify the economic impacts of widening and deepening the Canal, thus allowing different diversion ratios of traffic from Cape Henry to the C&D Canal. This study has also been completed.

These two studies have a strong relationship with the Brewerton study. Because of the symbiotic effects, the value of implementing any one of these projects, given the implementation of another, is not simply additive. The introduction of improvements to the C&D Canal, for instance, would significantly change traffic patterns in and around the Brewerton Extension. As discussed later, however, no improvements of this nature are reflected in the analysis of the Brewerton Channel Eastern Extension.

The primary tool utilized in the study was a simulation model that had previously been employed by the Galveston District Corps of Engineers on a study of the Houston Ship Channel. Because of the dynamics of the vessel movements and the inability to effectively define an analytical approach to the problem, it was decided that a simulation analysis would be more effective than one based on a queuing strategy.

## PROBLEM OVERVIEW

The purpose of this simulation study is to assess the impact of widening the Brewerton Extension on traffic patterns. An increase in the width of the Brewerton would improve the flow of vessels already utilizing the Extension, and encourage the use of the Brewerton Extension by other vessels. It is generally true that the presence of a wider channel would result in faster service times for vessels utilizing the Brewerton Extension. Moreover, the expedited movements of these vessels would also, to some extent, expedite the movements of other, non-Brewerton, vessels, whose flows are impacted by the presence of these Brewerton-bound ships.

On the other hand, the capacity of a vessel to accrue the benefits of expedited transition in the Brewerton Extension is potentially attenuated by the ability of the main channel to accommodate those vessels into the port facilities. As such, the benefits achievable are not merely a function of the reduced per vessel travel time. The overall impact of any improvement is a function of a number of factors:

- a) fraction of System traffic utilizing the C&D Canal;
- b) fraction of System traffic utilizing Cape Henry;
- c) fraction of C&D traffic utilizing the Brewerton Extension;
- d) Port service rates;
- e) System arrival rates;
- f) rates of vessel encounters (i.e. channel passings and meetings);
- g) vessel dimensions.

## INFORMATION RESOURCES

A number of resources were utilized in preparing this analysis for Baltimore. We identify each below, indicating the primary use of the source.

1. Baltimore Harbor Anchorages and Channels, Maryland: Reconnaissance Report and Supporting Technical Appendices, Baltimore District, Corps of Engineers, April 1992.

The reconnaissance report provided the basis for developing the simulation model. From this report, it was determined that the simulation methodology applied in a previous project for the Galveston Corps of Engineers could be substantively applied in Baltimore as well.

2. Tariff Sheet #6: Pilotage Rates for Chesapeake Bay and Tributaries, Association of Maryland Pilots, Effective: October 15, 1994.

This document was utilized to develop approximate hourly pilotage charges for vessels in the system. The charge is based on "pilotage units", which are a function of the vessel's LOA, breadth and depth.

3. Port Facilities at Baltimore, Maryland, Water Resources Support Center, Field Data: October, 1989, Aerial Photography: January 1983 and January, 1990.

These maps were utilized to locate the various port facilities in the system, for input into the simulation model.

4. The Port of Baltimore, Maryland, Port Series No. 10, Water Resources Support Center, Revised 1991.

In conjunction with the maps, this information was utilized to characterize the ports.

5. Vessel Traffic Information, Baltimore Maritime Exchange, 1991-93.

This information assisted in the calibration of the model.

6. Vessel Forecasts, DRI/McGraw-Hill, 1995.

DRI/McGraw-Hill provided estimates of the numbers of each vessel type calling on the system for the years 2000, 2010, 2020, 2030, 2040, and 2050. These forecasts were used in the simulation to create the representative vessel traffic. This information is included as an Annex to the Economics Appendix.

7. Information on the anticipated Masonville Terminal, Maryland Port Administration.

A 1981 study by the Port Administration identified the future need for a new terminal in the system. This terminal is now expected to be functional around 2005. The relevant

information was utilized in simulations of years following 2005.

8. Deep Draft Vessel Costs, Institute For Water Resources.

This information was used to define an average operating costs for each of the vessel types that calls on the Port of Baltimore.

9. Pilot Simulation Study and Questionnaire, Waterways Experiment Station (WES).

The study by WES provided information on the expected performance of pilots utilizing the Brewerton Extension during an encounter of two design vessels. This was utilized to define promising widening alternatives. The questionnaire, designed by the Brewerton Extension Study Group, assisted in identifying likely utilizing percentages for both the with and without project environments. Pilot responses were used to determine the circumstances affecting the decision to use the Brewerton Extension.

## **SIMULATION OVERVIEW**

A system that is suitable for simulation usually consists of at least one of the following two characteristics. First, the system might contain a significant amount of activity that is probabilistic in nature. Uncertainty of an activity may influence whether the activity occurs, when the activity occurs, and to what level the activity occurs. For instance, in modeling a ship arriving to the system, there are a number of uncertain elements:

- a) time of arrival to the system;
- b) time to complete service at the dock;
- c) whether the vessel is involved in an encounter (possibly a collision) with a second vessel;
- d) what type of vessel is calling on the port;
- e) etc.

It is noteworthy to point out that at some point in time, these elements may in fact gain certainty. For instance, we might know with accuracy within minutes the arrival times of all vessels calling on the Port tomorrow. However, this analysis must address the issue as an uncertain one, particularly in light of the need to provide some decision-making capabilities over a 50-year period.

The second key system characteristic that lends itself to a simulation analysis is pure complexity. That is, a system may consist of a number of interacting activities, each of which alone might be amenable to an analytical solution, but not true in the aggregate. Again, with respect to the harbor system, it might be a very straightforward analysis to define the equipment needs of a particular dock in the system. Even if each of these elements alone could be evaluated simply, interaction effects make a global analysis much more difficult.

For example, let us again consider the harbor system. There are a number of functions which

together define vessel movements:

- a) vessel transit;
- b) anchorage management;
- c) pilotage;
- d) docking pilot service;
- e) offload/onload;
- f) selected travel path within the Port System.

The simulation is a "What if...?" type of tool. Each element in the system is defined by what are deemed to be its key characteristics. For instance, in this simulation model, the key element was the ability of a vessel to select among alternative paths from origin to destination. In addition, the analysis must address the following:

- a) fraction of vessels that select a particular alternative path;
- b) vessel dimensions (which impact on transit rates when vessel encounters occur).

One common element in all simulation models is the employment of various probability distributions. The concept of a probability distribution is that some characteristic might differ over elements in the system, and the distribution indicates how that variation arises. For instance, a number of different vessel classes call on the Port of Baltimore. We define a distribution which ensures that the proportion and numbers of each class are consistent with current observations and future expectations.

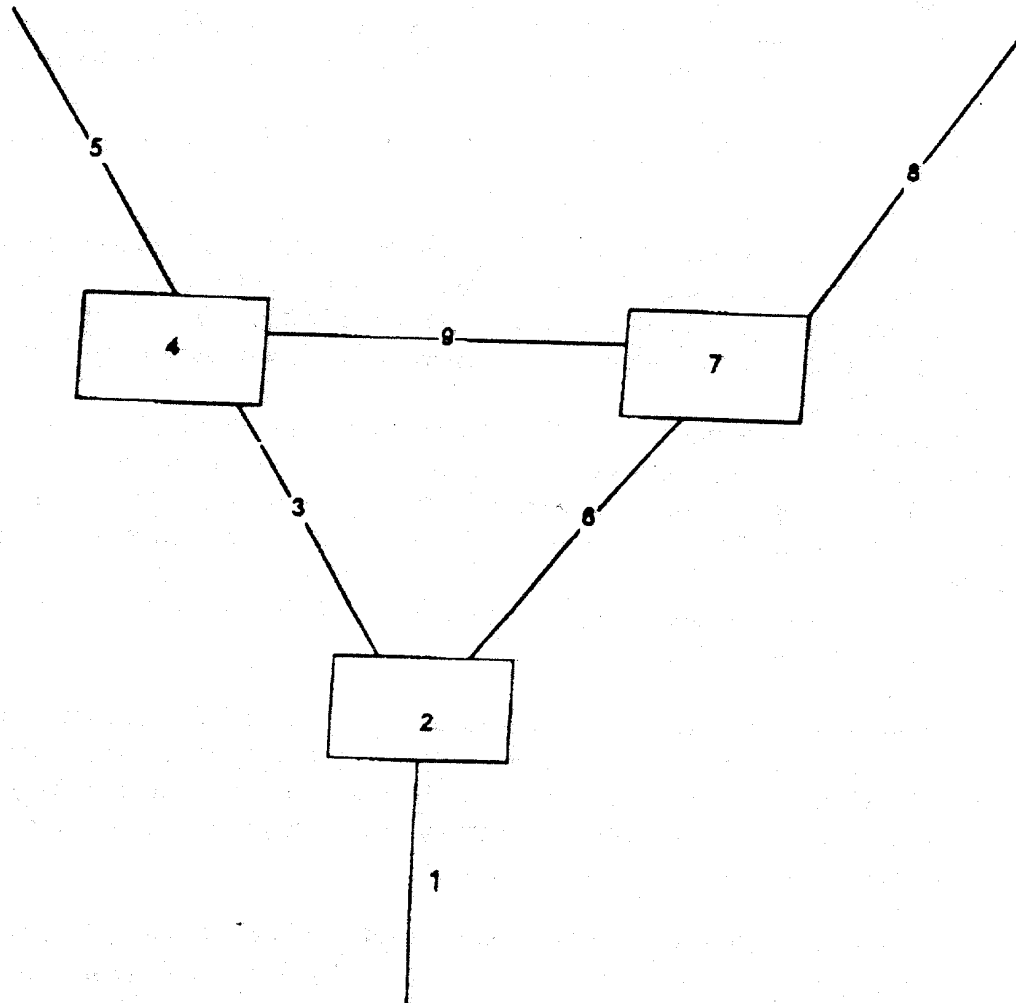
It is important to note that the level of detail to which an element is modeled should depend on the questions to be investigated with the simulation model. It is not possible to completely mimic that activity of the system. At the same time, important characteristics should not be omitted. The purpose of this analysis was to consider a number of fundamental questions. These include:

- a) How are delays reduced by the presence of a widened Extension?
- b) What is the financial impact of such a change?
- c) How extensive is the value for future traffic?
- d) Do the benefits justify the costs?

## THE MODEL

The simulation model created is essentially an imitation of vessel movements within the Port System. The original model was developed for the Galveston District Corps of Engineers, in attempting to identify the impact of deepening and widening the main Houston Ship Channel (HSC). Modifications were done with respect to the needs of the Baltimore Harbor Anchorages and Channels investigation. The modeling of the Brewerton Channel Eastern Extension essentially follows that of the HSC Study, with the primary exception being that vessels now have alternative paths between origin and destination. A schematic of the model is shown in Figure 1.

**CELL STRUCTURE**  
Brewerton Extension Study  
Simulation by M. Racer  
7/96



**CELL: LOCATION**

- 1: Cape Henry Entry
- 2: Junction 1
- 3: Craighill
- 4: Junction 2
- 5: Port of Baltimore
- 6: Swan Point
- 7: Junction 3
- 8: C&D
- 9: Brewerton Extension

This figure models the Baltimore Harbor system as a set of nine cells. Each cell represents a distinct segment of channel, with intersections of three major channel segments occurring at what are termed "junctions:"

- a) Junction 1 is the meeting of the Cape Henry, Swan Point, and Craighill channels;
- b) Junction 2 is the meeting of the Port of Baltimore, Craighill, and Brewerton Extension segments;
- c) Junction 3 is the meeting of the Swan Point, C&D Canal, and Brewerton Extension segments.

The purpose of employing such a model is to capture explicitly the impacts of shifts in traffic into the Extension. It is anticipated that this shift will influence the benefits not only of those vessels that shift, but also those that continue as historically done. The following is noted:

- a) Vessels utilizing the Brewerton Extension (segment 9) will be directly impacted by a channel improvement;
- b) Vessels utilizing segments 5 and 8 include those that have utilized the Brewerton Extension. Thus vessel movements in these segments are directly impacted;
- c) Vessels utilizing the Brewerton Extension directly interact with other vessels in segments 3,5,6, and 8. This is part of the "trickle-down" effect of modifying the Brewerton Extension;
- d) Vessels utilizing the Brewerton Extension potentially interact with other vessels that will ultimately use segment 1.

It was determined that this study will only consider the impacts of widening the Brewerton Extension. No other modifications are under review. Existing C&D Canal and Baltimore Harbor traffic are assumed to remain constant with respect to modifications. The possibility does, however, exist for realignments of the traffic distribution across the vessel types. Vessel type definitions are provided in Table 1.

There are several cost components included in the model. For each vessel class, there is a pilotage cost, and an hourly operating cost. The model defines general vessel classes, with average dimensions. For instance, every vessel in a particular class will have the same draft. (As referenced earlier, these definitions are based on the vessel categories of DRI / McGraw-Hill and the information provided by the Water Resources Support Center.) Vessel class characteristics are provided in Table 2. Arrival rates by vessel class are provided in Table 3.

#### ADDITIONAL OUTPUT

In addition to the standard outputs, two new outputs have been produced for the Brewerton Study. These are:

- a) Effective Arrival/Departure Rates, by origin/destination

This recognizes that arrivals (departures) are as much a function of those that do not arrive as of those which do. A general arrival rate formulation identifies the number of vessels that

arrive during a period, and divides that by the length of the period. For instance, an output that shows the arrival of 8 vessels in a five-day period has an arrival rate of 1.6 vessels per day. An "effective arrival rate" scheme accounts for all vessels bound for that destination. Again, for the example, suppose that there are also three other vessels in the system (e.g. in anchorage) bound for that destination, but unable to arrive because of service limitations. Thus, the effective arrival rate to the destination is 89% (8/11) of 1.6 per day. Similarly, the departure rate would be affected by the capacity of the destination to accept the departing vessel.

b) Effective Arrival/Departure Rates, by origin/destination and vessel class;

This table is similar to the previous, now including the additional information on specific rates with respect to vessel class. This information is shown in Tables 4 and 5.

### ALTERNATIVES

The various scenarios simulated were used to assess the value of widening the Brewerton Extension. The parameters to be modified include the following:

- Width of the Brewerton Extension;
- Vessel arrival rates;
- Utilization rates of the Extension.

The major operational change is that the Brewerton Extension is to be widened. The purpose of this study is to determine a preferred width, based on a benefit-cost tradeoff analysis. The standard practice in such analyses is to consider the benefits and costs as they accrue over some time period. In the current study, a period of 20 years is simulated. Over time, the number and types of vessels visiting the Port of Baltimore is expected to change. By modeling various years, the overall anticipated impact of the modifications can be better determined.

The single most important uncertainty in the model is a precise understanding of the decision by a pilot to select between the Brewerton Extension and the Swan Point-Craighill Channel route. While the Brewerton Extension offers a shorter route between the C&D Canal and the docks, the need to turn onto/off the Brewerton Extension, and the undesirability of encounters within the Extension sometimes discourages pilots from utilizing the Extension or causes pilots to delay their inbound or outbound transits. Preliminary estimates suggest, however, that the vast majority of pilots use the Brewerton Extension if the vessel is of appropriate dimension. Of the foreign cargo vessels using the C&D Canal, anecdotal information indicates that 98 percent of these vessels choose to traverse the Brewerton Channel Eastern Extension with the remaining two percent using the Swan Point approach. Because of this uncertainty, some simulation runs have been performed in order to assess the impact of not knowing the precise utilization rate. Variations around 98 percent were considered.

Since a simulation is, by its nature, a descriptive tool rather than a prescriptive one, there is

the desire to consider a number of alternative scenarios, to ensure that the best choice is, in some sense, "bracketed" by the set of alternatives. At the same time, a simulation is computationally intensive, in the sense that a number of replications of each scenario must be performed. As a consequence, there is some need to limit the total set of scenarios to a manageable number, and provide a strong analysis within that realm.

The set of simulation scenarios evaluated for the Brewerton Extension are shown in Table 6.

**TABLE 1**

**Vessel Class Definitions**

**Class Cargo and Capacity Characteristics**

AA General Cargo > 10K DWT  
 AB General Cargo < 10K DWT  
 A1 Cellular < 1000 TEU  
 A2 Cellular 1000 - 2499 TEU  
 A3 Cellular 2500 - 3999 TEU  
 A4 Cellular 4000 - 5999 TEU  
 AE Roll-on/Roll Off > 10K  
 AF Roll-on/Roll Off < 10K  
 DA Bulk < 20K DWT  
 DB Bulk 20-40K DWT  
 DC Bulk 40-80K DWT  
 DD Bulk 80-100K DWT  
 DE Bulk 100-175K DWT  
 EC Combination 40-80K DWT  
 ED Combination 80-100K DWT  
 FA Tanker < 10K DWT  
 FB Tanker 10-40K DWT  
 FC Tanker 40-80K DWT  
 FD Tanker 80-100K DWT  
 HB Vehicle Carrier  
 PA Product Tanker < 10K DWT  
 PB Product Tanker 10-40K DWT  
 PC Product Tanker 40-80K DWT  
 PD Product Tanker 80-100K DWT

**TABLE 2**

**Sample of Vessel Class Model Characteristics**

Cls: class

bm: beamwidth (feet)

drf: draft (feet)

LOA: length-overall (feet)

speed: speed (mph)

costs:

-hourly operating

-pilotage

-dispatch (disp-per indicates length of dispatch period (hours)

ext%: percentage of vessels of the class that will utilize the Extension

Cls	bm	drf	LOA	speed	hourly cost	pilotage cost	disp cost	disp-per	ext%
A1	73	25	482	17	738	140	0	72	.98
A2	94	34	676	18	1270	141.4	0	72	.98
A3	112	41	853	20	1492	142.12	0	72	.98
A4	117	43	905	20	1664	142.12	0	72	.98
AA	76	32	542	17	751	141.4	417	72	.98
AB	64	25	447	17	576	140	417	72	.98
AE	76	32	542	17	751	141.4	0	72	.98
AF	64	25	447	17	576	140	0	72	.98
DA	67	28	478	14	564	140	417	72	.98
DB	83	34	583	14	692	141.4	417	72	.98
DC	105	43	717	14	888	142.12	417	72	.98
DD	119	49	780	14	1049	142.12	417	72	.98
DE	136	55	910	14	1233	142.6	417	72	.98
EC	109	42	585	14	1158	141.4	417	72	.98
ED	125	47	800	14	1293	142.12	417	72	.98
FA	76	30	519	14	891	141.4	417	72	.98
FB	87	34	585	14	971	141.4	417	72	.98
FC	109	42	585	14	1158	141.4	417	72	.98
FD	125	47	800	14	1293	142.12	417	72	.98
HB	64	25	447	17	576	140	417	72	.98
PA	76	30	519	14	891	141.4	417	72	.98
PB	87	34	585	14	971	141.4	417	72	.98
PC	109	42	585	14	1158	141.4	417	72	.98
PD	125	47	800	14	1293	142.12	417	72	.98

**TABLE 3****Vessel Class Arrival Patterns****Proportion of Total Traffic**

Class	2000	2010	2020	2030
AA	.11	.09	.09	.09
AB	.02	.01	.01	.01
A1	.03	.04	.05	.06
A2	.23	.22	.20	.19
A3	.06	.07	.09	.09
A4	.03	.06	.09	.12
AE	.16	.17	.16	.15
AF	.01	.01	.01	.01
DA	.05	.06	.09	.03
DB	.06	.06	.06	.05
DC	.03	.03	.02	.02
DD	.01	.01	.01	.01
DE	.02	.01	.04	.04
EC	.01	.01	.01	.01
ED	.01	.01	.01	.01
FA	.01	.01	.01	.01
FB	.01	.01	.01	.01
FC	.01	.01	.01	.01
FD	.01	.01	.01	.01
HB	.08	.08	.08	.08
PA	.01	.01	.01	.01
PB	.01	.01	.01	.01
PC	.01	.01	.01	.01
PD	.01	.01	.01	.01

**TABLE 4****Vessel Traffic Information - By Decade**

<b>Decade</b>		<b>#round trips/day</b>	<b>#trips in 73 days</b>
2000	2000	9.4	686
	2010	13.2	964
	2020	20.8	1518
	2030	28.6	2088
	2040	40.0	2920
	2050	55.6	4059

**TABLE 5**

**Summary of Daily Flow Rates Specified Origins**  
**{utilizing information from Philadelphia C&D Canal**  
**Study without project conditions}**

**INBOUND TO BALTIMORE**

<b>Year</b>	<b>2000</b>	<b>2010</b>	<b>2020</b>
C&D Canal to Harbor	1.5	2.3	3.4
Cape Henry to Harbor	7.9	10.9	17.4
<b>TOTAL</b>	<b>9.4</b>	<b>13.2</b>	<b>20.8</b>

**OUTBOUND TO BALTIMORE**

<b>Year</b>	<b>2000</b>	<b>2010</b>	<b>2020</b>
Harbor to C&D Canal	1.3	2.0	2.9
Harbor to Cape Henry	8.1	11.2	17.9
<b>TOTAL</b>	<b>9.4</b>	<b>13.2</b>	<b>20.8</b>

**TABLE 6****Summary of Scenarios**

<b>Scenario Name</b>	<b>Year</b>	<b>Dimension</b>	<b>Percent Utilization</b>
Without Condition	2000	450'	95, 98, 99
	2010		
	2020		
Improved Condition	2000	550'	95, 98, 99
	2010		
	2020		
Improved Condition	2000	600'	95, 98, 99
	2010		
	2020		
Improved Condition	2000	650'	95, 98, 99
	2010		
	2020		

## **BENEFIT ANALYSIS**

Based on requests from the Maryland Port Administration (MPA) and representatives of the Association of Maryland Pilots (AMP), this effort has analyzed the existing channel width and various increments of widening including the authorized width of 600 feet. This analysis did not consider channel deepening as an alternative to be investigated. Through the use of the simulation modeling tool, widths of 450-feet, 550-feet, and 600-feet were evaluated. The widening of the Brewerton Channel Eastern Extension to 500 feet was not included in this economic analysis because vessel design studies conducted by the Waterways Experiment Station (WES) determined this alternative was not viable from a vessel design, vessel operation, and safety perspective. The economic analysis of alternatives is based on a "without project" condition of a 450-foot wide channel. The several "with project" scenarios are represented by the 550-foot and 600-foot alternatives.

Project benefits are based on transportation savings accruing to the entire vessel fleet calling on the Port of Baltimore as a result of improved passage through the Brewerton Channel Eastern Extension. The benefits are manifested primarily through reduced vessel operating costs, reduced pilotage costs, and time savings that are achieved as a result of the improved condition. Vessel movements and vessel fleet composition are based on detailed analyses of commodity flows and vessel fleet conducted by DRI/McGraw-Hill and included as an annex. Vessel operating costs are based on FY1995 Deep Draft Vessel Cost information published by the Institute for Water Resources (IWR).

As discussed in a previous section, multiple simulation runs were executed for each alternative considered. Simulations were conducted for a 73-day period for each of the benchmark years 2000-2020. Repeated simulations of longer periods of time increase the run time. Since seasonality of traffic was not a factor, a 73-day period was appropriate. Analysis of later benchmark years (2030-2050) was not conducted because of system infrastructure limitations revealed in earlier analyses conducted as part of the Baltimore Harbor Anchorages and Channels Feasibility study. Differences in operating conditions between the "without project" and the "with project" conditions were annualized over a 50-year period using the current Federal discount rate of 7-3/8 percent. Year 2020 operating conditions (and savings related to channel improvements) were held constant for the duration of the 50-year period due to the system limitations.

Table 7 and Table 8 illustrate how the simulation outputs have been summarized. The "without project" condition, i.e. the 450-foot wide channel, is represented by a series of outputs for each benchmark year. Total operating costs for vessels that have completed passage through the port system are presented by benchmark year. The improved condition is similarly presented in the lower part of the table. Because the simulations were executed for a 73-day period, the changes from the "without project" condition are converted to a 365-day period and are shown as benefits.

# TABLE 7

## BREWERTON CHANNEL EASTERN EXTENSION 450-FOOT WITHOUT PROJECT CONDITION SYSTEM OPERATING COSTS (1995 PRICES)

	VESSEL			VESSEL			VESSEL			VESSEL			VESSEL			VESSEL		
	YEAR 2000	CALLS	YEAR 2010	CALLS	YEAR 2020	CALLS	YEAR 2030	CALLS	YEAR 2040	CALLS	YEAR 2050	CALLS	YEAR 2060	CALLS	YEAR 2070	CALLS	YEAR 2080	CALLS
RUN 1	\$18,867,032	1391	\$30,763,605	2032	\$45,423,913	2964	\$45,423,913	2964	\$45,423,913	2964	\$45,423,913	2964	\$45,423,913	2964	\$45,423,913	2964	\$45,423,913	2964
RUN 2	\$18,956,526	1591	\$28,017,713	1891	\$48,418,844	2998	\$48,418,844	2998	\$48,418,844	2998	\$48,418,844	2998	\$48,418,844	2998	\$48,418,844	2998	\$48,418,844	2998
RUN 3	\$19,477,681	1782	\$29,303,921	2215	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981
RUN 4	\$19,868,666	1574	\$27,363,171	1977	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031
RUN 5	\$19,313,456	1676	\$27,470,103	2312	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046
RUN 6	\$19,550,261	1725	\$28,651,679	2025	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863
RUN 7	\$19,207,275	1503	\$29,153,556	2259	\$42,422,642	2986	\$42,422,642	2986	\$42,422,642	2986	\$42,422,642	2986	\$42,422,642	2986	\$42,422,642	2986	\$42,422,642	2986
RUN 8	\$19,707,019	1380	\$29,400,352	2203	\$41,363,590	2966	\$41,363,590	2966	\$41,363,590	2966	\$41,363,590	2966	\$41,363,590	2966	\$41,363,590	2966	\$41,363,590	2966
AVERAGE	\$19,368,490	1578	\$28,765,513	2114	\$43,790,207	2979	\$43,790,207	2979	\$43,790,207	2979	\$43,790,207	2979	\$43,790,207	2979	\$43,790,207	2979	\$43,790,207	2979
UNIT COSTS	\$12,276		\$13,606		\$14,698		\$14,698		\$14,698		\$14,698		\$14,698		\$14,698		\$14,698	

## BREWERTON CHANNEL EASTERN EXTENSION 550-FOOT WITH PROJECT CONDITION SYSTEM OPERATING COSTS (1995 PRICES)

	VESSEL			VESSEL			VESSEL			VESSEL			VESSEL			VESSEL		
	YEAR 2000	CALLS	YEAR 2010	CALLS	YEAR 2020	CALLS	YEAR 2030	CALLS	YEAR 2040	CALLS	YEAR 2050	CALLS	YEAR 2060	CALLS	YEAR 2070	CALLS	YEAR 2080	CALLS
RUN 1	\$19,267,827	1775	\$29,811,018	2229	\$45,422,387	2964	\$45,422,387	2964	\$45,422,387	2964	\$45,422,387	2964	\$45,422,387	2964	\$45,422,387	2964	\$45,422,387	2964
RUN 2	\$18,630,918	1672	\$28,558,144	2248	\$44,089,855	3094	\$44,089,855	3094	\$44,089,855	3094	\$44,089,855	3094	\$44,089,855	3094	\$44,089,855	3094	\$44,089,855	3094
RUN 3	\$19,515,136	1783	\$28,975,277	2254	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981
RUN 4	\$19,697,428	1777	\$28,513,723	2151	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031
RUN 5	\$19,856,694	1747	\$27,507,171	2313	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046
RUN 6	\$19,550,261	1725	\$29,049,021	2327	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863
RUN 7	\$20,561,146	1757	\$29,620,638	2273	\$42,421,436	2986	\$42,421,436	2986	\$42,421,436	2986	\$42,421,436	2986	\$42,421,436	2986	\$42,421,436	2986	\$42,421,436	2986
RUN 8	\$19,870,065	1783	\$28,552,254	2322	\$42,363,590	2966	\$42,363,590	2966	\$42,363,590	2966	\$42,363,590	2966	\$42,363,590	2966	\$42,363,590	2966	\$42,363,590	2966
AVERAGE	\$19,618,684	1752	\$28,823,406	2265	\$43,373,742	2991	\$43,373,742	2991	\$43,373,742	2991	\$43,373,742	2991	\$43,373,742	2991	\$43,373,742	2991	\$43,373,742	2991
UNIT COST DIFFERENCE	\$11,195	175	\$12,728	150	\$14,500	12	\$14,500	12	\$14,500	12	\$14,500	12	\$14,500	12	\$14,500	12	\$14,500	12
CHANGE	\$1,893,505		\$1,988,040		\$592,839		\$592,839		\$592,839		\$592,839		\$592,839		\$592,839		\$592,839	
BENEFIT	\$9,467,525		\$9,940,199		\$2,964,193		\$2,964,193		\$2,964,193		\$2,964,193		\$2,964,193		\$2,964,193		\$2,964,193	

CHANGES SHOWN ARE BASED ON A 73-DAY SIMULATION OF DAILY VESSEL MOVEMENTS IN THE PORT OF BALTIMORE  
COST CHANGES ARE CONVERTED TO A 365-DAY BASIS TO REFLECT ANNUAL BENEFITS FROM THE IMPROVEMENT

THE RESULTANT OPERATING

TAFES

**BREWERTON CHANNEL EASTERN EXTENSION  
450-FOOT WITHOUT PROJECT CONDITION  
SYSTEM OPERATING COSTS  
(1995 PRICES)**

	VESSEL				VESSEL				VESSEL				VESSEL			
	YEAR 2000	CALLS	YEAR 2010	CALLS	YEAR 2020	CALLS	YEAR 2030	CALLS	YEAR 2040	CALLS	YEAR 2050	CALLS	YEAR 2060	CALLS	YEAR 2070	CALLS
RUN 1	\$18,867,032	1391	\$30,763,605	2032	\$45,423,913	2964	\$45,423,913	2964	\$45,423,913	2964	\$45,423,913	2964	\$45,423,913	2964	\$45,423,913	2964
RUN 2	\$18,956,526	1591	\$28,017,713	1891	\$48,418,844	2998	\$48,418,844	2998	\$48,418,844	2998	\$48,418,844	2998	\$48,418,844	2998	\$48,418,844	2998
RUN 3	\$19,477,681	1782	\$29,303,921	2215	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981	\$42,726,278	2981
RUN 4	\$19,868,666	1574	\$27,363,171	1977	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031	\$41,971,905	3031
RUN 5	\$19,313,456	1676	\$27,470,103	2312	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046	\$44,772,256	3046
RUN 6	\$19,550,261	1725	\$28,651,679	2025	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863	\$43,222,226	2863
RUN 7	\$19,207,275	1503	\$29,153,556	2259	\$42,422,642	2986	\$42,422,642	2986	\$42,422,642	2986	\$42,422,642	2986	\$42,422,642	2986	\$42,422,642	2986
RUN 8	\$19,707,019	1380	\$29,400,352	2203	\$41,363,590	2966	\$41,363,590	2966	\$41,363,590	2966	\$41,363,590	2966	\$41,363,590	2966	\$41,363,590	2966
AVERAGE	\$19,368,490	1578	\$28,765,513	2114	\$43,790,207	2979	\$43,790,207	2979	\$43,790,207	2979	\$43,790,207	2979	\$43,790,207	2979	\$43,790,207	2979
UNIT COSTS	\$12,276		\$13,606		\$14,698		\$14,698		\$14,698		\$14,698		\$14,698		\$14,698	

**BREWERTON CHANNEL EASTERN EXTENSION  
600-FOOT WITH PROJECT CONDITION  
SYSTEM OPERATING COSTS  
(1995 PRICES)**

	VESSEL				VESSEL				VESSEL				VESSEL			
	YEAR 2000	CALLS	YEAR 2010	CALLS	YEAR 2020	CALLS	YEAR 2030	CALLS	YEAR 2040	CALLS	YEAR 2050	CALLS	YEAR 2060	CALLS	YEAR 2070	CALLS
RUN 1	\$19,267,827	1775	\$28,598,244	2291	\$43,361,246	3300	\$43,361,246	3300	\$43,361,246	3300	\$43,361,246	3300	\$43,361,246	3300	\$43,361,246	3300
RUN 2	\$19,433,727	1766	\$29,042,015	2288	\$44,099,654	3322	\$44,099,654	3322	\$44,099,654	3322	\$44,099,654	3322	\$44,099,654	3322	\$44,099,654	3322
RUN 3	\$19,515,136	1783	\$28,573,697	2298	\$41,945,931	3300	\$41,945,931	3300	\$41,945,931	3300	\$41,945,931	3300	\$41,945,931	3300	\$41,945,931	3300
RUN 4	\$19,550,261	1725	\$29,620,638	2273	\$42,885,368	3218	\$42,885,368	3218	\$42,885,368	3218	\$42,885,368	3218	\$42,885,368	3218	\$42,885,368	3218
RUN 5	\$19,958,082	1785	\$29,049,021	2327	\$45,207,147	3397	\$45,207,147	3397	\$45,207,147	3397	\$45,207,147	3397	\$45,207,147	3397	\$45,207,147	3397
AVERAGE	\$19,545,007	1767	\$28,976,723	2295	\$43,499,869	3307	\$43,499,869	3307	\$43,499,869	3307	\$43,499,869	3307	\$43,499,869	3307	\$43,499,869	3307
UNIT COST	\$11,062		\$12,624		\$13,152		\$13,152		\$13,152		\$13,152		\$13,152		\$13,152	
DIFFERENCE	\$1,214	189	\$982	181	\$1,545	328	\$1,545	328	\$1,545	328	\$1,545	328	\$1,545	328	\$1,545	328
CHANGE	\$2,144,264		\$2,253,433		\$5,111,578		\$5,111,578		\$5,111,578		\$5,111,578		\$5,111,578		\$5,111,578	
BENEFIT	\$10,721,322		\$11,267,165		\$25,557,889		\$25,557,889		\$25,557,889		\$25,557,889		\$25,557,889		\$25,557,889	

NOTE: CHANGES SHOWN ARE BASED ON A 73-DAY SIMULATION OF DAILY VESSEL MOVEMENTS IN THE PORT OF BALTIMORE. THE RESULTANT OPERATING COST CHANGES ARE CONVERTED TO A 365-DAY BASIS TO REFLECT ANNUAL BENEFITS FROM THE IMPROVEMENT.

# TABLE 9

## BREWERTON CHANNEL EASTERN EXTENSION

550-FOOT-98%-WITH PROJECT ALTERNATIVE  
(1995 PRICES, 7.375 DISCOUNT RATE)

		YEAR	7.375 PERCENT (1/(1.07375^N))	PRESENT WORTH
YEAR 2000	\$9,467,525	1	\$9,467,525	\$8,817,253
		2	\$9,467,525	\$8,211,644
YEAR 2010	\$9,940,199	3	\$9,467,525	\$7,647,631
		4	\$9,467,525	\$7,122,357
YEAR 2020	\$2,964,193	5	\$9,467,525	\$6,633,162
		6	\$9,467,525	\$6,177,566
YEAR 2030	\$2,964,193	7	\$9,467,525	\$5,753,263
		8	\$9,467,525	\$5,358,103
YEAR 2040	\$2,964,193	9	\$9,467,525	\$4,990,084
		10	\$9,467,525	\$4,647,343
YEAR 2050	\$2,964,193	11	\$9,940,199	\$4,544,228
		12	\$9,940,199	\$4,232,110
		13	\$9,940,199	\$3,941,430
		14	\$9,940,199	\$3,670,714
		15	\$9,940,199	\$3,418,593
		16	\$9,940,199	\$3,183,789
		17	\$9,940,199	\$2,965,112
		18	\$9,940,199	\$2,761,455
		19	\$9,940,199	\$2,571,785
		20	\$9,940,199	\$2,395,144
		21	\$2,964,193	\$665,181
		22	\$2,964,193	\$619,493
		23	\$2,964,193	\$576,944
		24	\$2,964,193	\$537,317
		25	\$2,964,193	\$500,411
		26	\$2,964,193	\$466,041
		27	\$2,964,193	\$434,031
		28	\$2,964,193	\$404,220
		29	\$2,964,193	\$376,456
		30	\$2,964,193	\$350,599
		31	\$2,964,193	\$326,519
		32	\$2,964,193	\$304,092
		33	\$2,964,193	\$283,205
		34	\$2,964,193	\$263,754
		35	\$2,964,193	\$245,638
		36	\$2,964,193	\$228,766
		37	\$2,964,193	\$213,054
		38	\$2,964,193	\$198,420
		39	\$2,964,193	\$184,792
		40	\$2,964,193	\$172,099
		41	\$2,964,193	\$160,279
		42	\$2,964,193	\$149,270
		43	\$2,964,193	\$139,018
		44	\$2,964,193	\$129,469
		45	\$2,964,193	\$120,577
		46	\$2,964,193	\$112,295
		47	\$2,964,193	\$104,582
		48	\$2,964,193	\$97,399
		49	\$2,964,193	\$90,709
		50	\$2,964,193	\$84,479
TOTAL			\$283,003,030	\$107,581,872
ANNUALIZED BENEFIT				\$8,166,916

# TABLE 10

## BREWERTON CHANNEL EASTERN EXTENSION

600-FOOT-98%-WITH PROJECT ALTERNATIVE  
(1995 PRICES, 7.375 DISCOUNT RATE)

		YEAR	7.375 PERCENT (1/(1.07375^N))	PRESENT WORTH
YEAR 2000	\$10,721,322	1 \$10,721,322	0.93131548	\$9,984,933
		2 \$10,721,322	0.86734853	\$9,299,123
YEAR 2010	\$11,267,165	3 \$10,721,322	0.80777511	\$8,660,417
		4 \$10,721,322	0.75229347	\$8,065,581
YEAR 2020	\$25,557,889	5 \$10,721,322	0.70062256	\$7,511,600
		6 \$10,721,322	0.65250064	\$6,995,669
YEAR 2030	\$25,557,889	7 \$10,721,322	0.60768394	\$6,515,175
		8 \$10,721,322	0.56594547	\$6,067,684
YEAR 2040	\$25,557,889	9 \$10,721,322	0.52707378	\$5,650,928
		10 \$10,721,322	0.49087197	\$5,262,796
YEAR 2050	\$25,557,889	11 \$11,267,165	0.45715666	\$5,150,860
		12 \$11,267,165	0.42575708	\$4,797,075
		13 \$11,267,165	0.39651416	\$4,467,590
		14 \$11,267,165	0.36927978	\$4,160,736
		15 \$11,267,165	0.34391597	\$3,874,958
		16 \$11,267,165	0.32029427	\$3,608,808
		17 \$11,267,165	0.29829501	\$3,360,939
		18 \$11,267,165	0.27780676	\$3,130,095
		19 \$11,267,165	0.25872574	\$2,915,106
		20 \$11,267,165	0.24095529	\$2,714,883
		21 \$25,557,889	0.22440539	\$5,735,328
		22 \$25,557,889	0.20899222	\$5,341,400
		23 \$25,557,889	0.19463769	\$4,974,528
		24 \$25,557,889	0.18126909	\$4,632,855
		25 \$25,557,889	0.16881871	\$4,314,650
		26 \$25,557,889	0.15722348	\$4,018,300
		27 \$25,557,889	0.14642466	\$3,742,305
		28 \$25,557,889	0.13636755	\$3,485,267
		29 \$25,557,889	0.12700121	\$3,245,883
		30 \$25,557,889	0.1182782	\$3,022,941
		31 \$25,557,889	0.11015432	\$2,815,312
		32 \$25,557,889	0.10258842	\$2,621,943
		33 \$25,557,889	0.09554218	\$2,441,857
		34 \$25,557,889	0.08897992	\$2,274,139
		35 \$25,557,889	0.08286837	\$2,117,941
		36 \$25,557,889	0.0771766	\$1,972,471
		37 \$25,557,889	0.07187576	\$1,836,993
		38 \$25,557,889	0.06693901	\$1,710,820
		39 \$25,557,889	0.06234134	\$1,593,313
		40 \$25,557,889	0.05805945	\$1,483,877
		41 \$25,557,889	0.05407167	\$1,381,958
		42 \$25,557,889	0.05035778	\$1,287,039
		43 \$25,557,889	0.04689898	\$1,198,639
		44 \$25,557,889	0.04367775	\$1,116,311
		45 \$25,557,889	0.04067776	\$1,039,638
		46 \$25,557,889	0.03788383	\$968,231
		47 \$25,557,889	0.0352818	\$901,728
		48 \$25,557,889	0.03285848	\$839,793
		49 \$25,557,889	0.03060161	\$782,113
		50 \$25,557,889	0.02849976	\$728,394
TOTAL		\$986,621,540		\$185,820,921
ANNUALIZED BENEFIT				\$14,106,316

Table 9 and Table 10 annualize the benefit stream for a 50-year period at the Federal discount rate of 7-3/8 percent. Based on this analysis, widening of the Brewerton Channel Eastern Extension to 550-feet will generate annualized benefits of \$8.2 million dollars. A widening of the Brewerton Channel Eastern Extension to 600 feet will result in annual benefits of \$14.1 million.

### **BENEFIT-COST RATIO**

Benefits were computed at 1995 prices based on the operating savings identified. For purposes of the economic analysis, costs were also computed at October 1994 (FY 95) prices. These baseline costs include mobilization, demobilization, dredging of material, transport of material, and placement of material. Also included are construction engineering and design costs and construction management costs. Costs associated with raising of the dike at Hart-Miller Island are also included in this estimate. Through discussions with the U.S. Coast Guard, it was determined there are no new project-related costs for aids to navigation. A detailed discussion of the project cost is found in Section 2 of the Main Report.

First costs for widening of the Brewerton Channel Eastern Extension to 550-feet were computed to be \$9,681,000. First costs for the 600-foot wide alternative have been computed to be \$12,673,000. Total investment costs are based on a six-month construction period. For the 550-foot widening alternative, total investment costs are \$9,855,000. For the 600-foot widening alternative, total investment costs are \$12,901,000. Annualized investment costs for the two alternatives are estimated to be \$748,000 and \$979,000, respectively. Annual incremental operation and maintenance costs for these alternatives are estimated to be \$166,700 and \$249,500, respectively.

Total annual cost for the 550-foot alternative is \$915,000. Total annual cost for the 600-foot alternative is \$1,229,000. Widening of the Brewerton Channel Eastern Extension to 550-feet results in benefit-cost ratio of 8.9 to 1 and produces net benefits of \$7,252,000 as shown in Table 11. Pursuit of the 600-foot channel widening alternative results in a benefit-cost ratio of 11.5 to 1 and produces net benefits of \$12,877,000 as shown in Table 12. The incremental annual cost of moving from the 550-foot wide channel to the 600-foot wide channel is estimated to be \$314,000. The incremental expenditure of \$314,000 associated with this additional 50-foot width is estimated to yield incremental benefits of \$5,939,000 for an incremental benefit-incremental cost ratio of 18.9 to 1. Based on the analysis presented, it is recommended that the Brewerton Channel Eastern Extension be improved from its current width of 450-feet to a width of 600-feet.

**TABLE 11**

**BREWERTON CHANNEL EASTERN EXTENSION  
550-FOOT WIDENING ALTERNATIVE  
BENEFIT-COST SUMMARY  
( 1995 PRICE LEVELS, \$000's)**

<b>ITEM</b>	<b>COSTS</b>
<b>INVESTMENT COST</b>	
Project First Cost	\$ 9,681
Interest During Construction	<u>174</u>
Total Investment Cost	\$ 9,855
<b>AVERAGE ANNUAL COST</b>	
Annualized Investment Cost	\$ 748
O, M, R, R, & R	<u>167</u>
Total Annual Cost	\$ 915
<b>AVERAGE ANNUAL BENEFITS</b>	
Navigation Cost Savings	\$ 8,167
<b>BENEFIT-COST RATIO</b>	<b>8.9</b>
<b>NET BENEFITS</b>	<b>\$ 7,252</b>

**TABLE 12**  
**BREWERTON CHANNEL EASTERN EXTENSION**  
**600-FOOT WIDENING ALTERNATIVE**  
**BENEFIT-COST SUMMARY**  
**( 1995 PRICE LEVELS, \$000's)**

<b>ITEM</b>	<b>COSTS</b>
<b>INVESTMENT COST</b>	
Project First Cost	\$12,673
Interest During Construction	<u>228</u>
Total Investment Cost	\$12,901
<b>AVERAGE ANNUAL COST</b>	
Annualized Investment Cost	\$ 979
O, M, R, R, & R	<u>250</u>
Total Annual Cost	\$ 1,229
<b>AVERAGE ANNUAL BENEFITS</b>	
Navigation Cost Savings	\$14,106
<b>BENEFIT-COST RATIO</b>	<b>11.5</b>
<b>NET BENEFITS</b>	<b>\$12,877</b>



**US Army Corps  
of Engineers  
BALTIMORE DISTRICT**

**Maryland Port Administration**

# **BREWERTON CHANNEL EASTERN EXTENSION LIMITED REEVALUATION REPORT**

## **WITHOUT PROJECT CONDITIONS REPORT**

Prepared as part of  
**BALTIMORE HARBOR 42-FOOT PROJECT,  
MARYLAND AND VIRGINIA**

Prepared for  
**US Army Engineer District, Baltimore**  
10 South Howard Street  
Baltimore, MD 21201

and

**Maryland Port Administration**

by:  
DRI/McGraw-Hill  
1200 G Street, N.W.  
Washington, D.C. 20005



## **Without Project Conditions**

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# **BALTIMORE HARBOR ANCHORAGES AND CHANNELS FEASIBILITY STUDY**

## **Without Project Conditions**

### **Purpose**

This report describes the without project conditions developed for the Baltimore Harbor Anchorages and Channels Feasibility Study for the year 2000 and beyond. This discussion includes a presentation of the without project forecasts of commodity volume and vessel fleet distribution for trade through the Port of Baltimore. The distribution of trade by route is presented for the major trade routes discussed in the Existing Conditions report prepared as part of this study. Also included is a description of the methodology used for identifying and forecasting the cargo and ballast moves for the Port of Baltimore for the without project conditions. Detailed presentations on the various econometric models used to develop the forecasts are presented in the annexes following the report, along with a detailed breakdown of vessel calls on the Port of Baltimore.

### **Methodology and Assumptions**

#### **Forecast Methodology**

This section is divided into three sections: (1) the methodologies used in DRI's forecast and (2) the assumptions underlying those methodologies; and (3) a discussion of the risks and uncertainty factors that should be considered when analyzing forecast results.

The baseline forecast for this study uses the "First Quarter 1995 DRI/Mercer World Sea Trade Service (WSTS) Forecast" released in March 1995 to make special projections for the Baltimore Harbor Anchorages and Channels analysis. (Annex A explains the WSTS forecast in detail.) At the time of the forecast Europe was in the midst of a recession and topical issues

included the "peso crisis" from December 1994 and an all time weak dollar against the yen and the Deutsche Mark. While Mexico is not terribly important to Baltimore itself and its crisis status dissipated quickly, it illustrates the recurring theme of interdependence of world markets which is key to the DRI approach.

The WSTS model itself is derived from the more complex DRI trade models. The trade models forecast trade in value terms using a complex econometric approach in which goods traded are subdivided into 59 product groups for 34 reporting countries' trade with major partner countries and regions. Each of those product groups is modeled separately incorporating macroeconomic forecasts for prices, market size, production, consumption, relative wealth (to size future markets) and historic trading patterns. The forecast covers trade through 2010. The WSTS model converts those dollar figures to tons and assigns the cargo to a shiptype. For the U.S., information for six standard coastal ranges is also available.

The long-term parameter forecast is an extension of the trade forecast beyond 2010. It covers the same information available in the standard WSTS and is first estimated in value terms. It uses a parametric model to keep the growth rates within reasonable boundaries.

In the World Fleet Forecast Service (WFFS), the WSTS output is assigned to 38 different vessel types and sizes of vessels by route. This model uses supply data from Lloyd's Maritime Information Services (LMIS) and demand data from DRI's WSTS model to project the future structure of the world merchant shipping fleet. For each route the model aggregates over commodities to generate the total amount of trade moving on each route by vessel type. Total cargo by shiptype is used to project shiptype capacity based on projected capacity utilization. The WFFS model then calculates the number of voyages needed to carry the allocated cargo, based on exogenously determined per-voyage capacity and voyages per shipyear. The ratios are generally projected to be decreasing as larger ships come on line in response to increased international trade and/or replacement.

The coastal outlook is then linked to port specific information and the port's trade and vessel activity is forecasted based on the assumption that the port's share of the coastal region it is part of will remain constant in the forecast period. For this project, additional vessel detail based on the Baltimore Maritime Exchange data on movements within the port and to and from anchorages was also linked to the forecasts. The projected growth by commodity between 1993 and 2000 is shown in Table 3 (Exports) and Table 5 (Imports). The projected growth by vessel type is included in Table 19.

#### *Base Year 2000*

The forecast for the year 2000 is the base year for the proposed project and therefore the base year for the study. The forecasts of trade and vessel fleet distribution are based on data as available in March 1995. The underlying U.S. regional, national, macroeconomic and world industry forecasts are the most current available as of March 1995. From these forecasts, new cargo and fleet forecasts were prepared for trade through the Port of Baltimore.

#### *Years 2000 - 2050*

The underlying forecast of world commodity trade and the cargo fleet for the years 2000 through 2010 were taken directly from the regular DRI/Mercer World Sea Trade Service and DRI/LMIS (Lloyd's Maritime Information Service) World Fleet Forecast Service (WFFS) forecasts available in March 1995. (Annex B is the methodology for the WFFS forecast; Annex C contains the methodology specifically developed for this long-term forecast.)

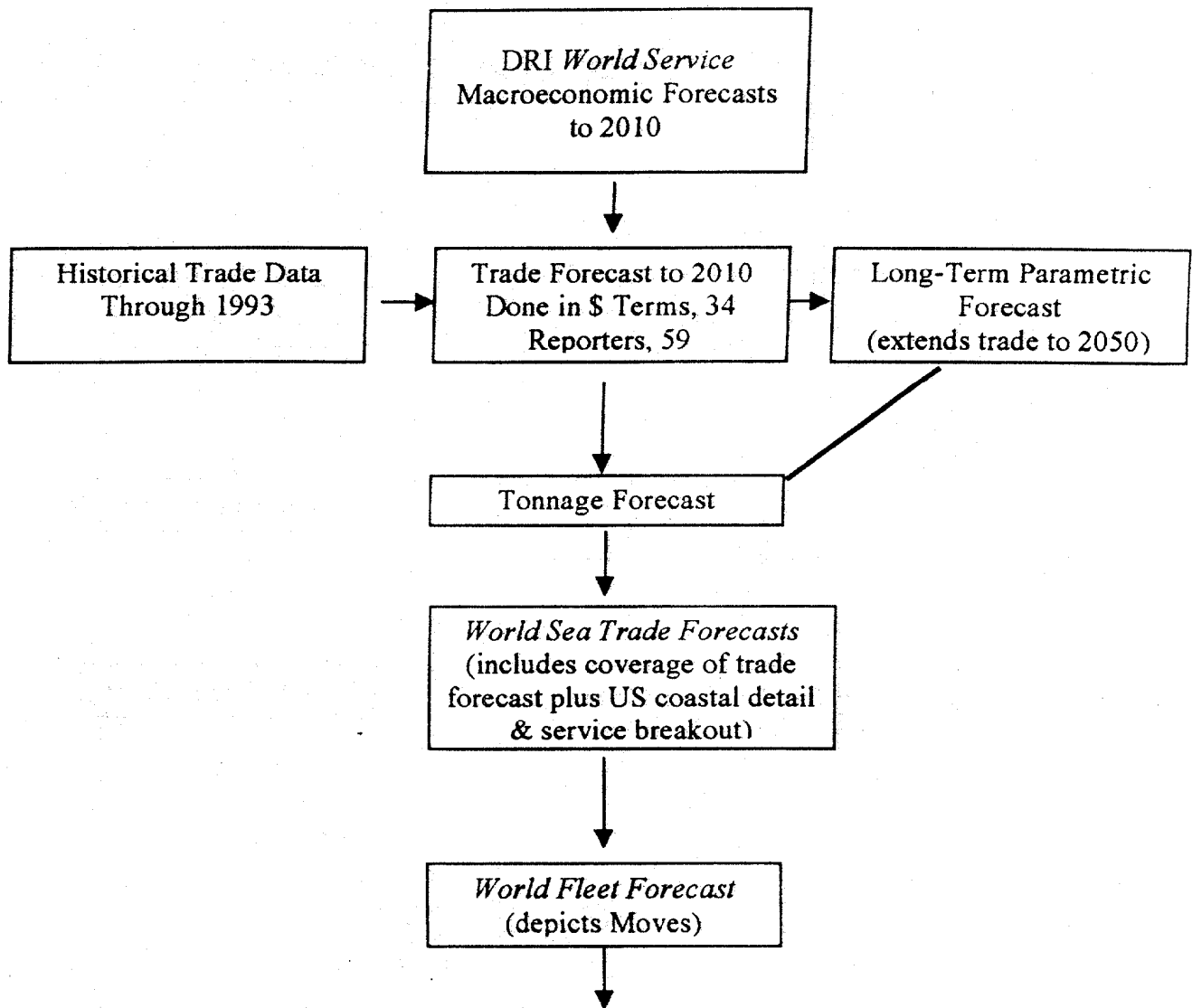
These forecasts of long-term activity in the Port of Baltimore are grounded in DRI's short-term forecasting models and include First Quarter 1995 commodity and vessel fleet information. These econometric models are based on global economic, demographic, and political activities and related trading patterns and are not constrained by factors such as existing infrastructure. The port-specific forecasts for the Port of Baltimore are also

unconstrained. Indeed, one of the many purposes served by forecasting commodity and vessel activity is the estimation of future infrastructure needs.

The commodity and vessel fleet forecasts developed by DRI and presented in this report were used as input to a simulation model developed for the Baltimore District, Corps of Engineers and the Maryland Port Administration as part of the Baltimore Harbor Anchorages and Channels Feasibility Study. This model simulated vessel movements within the Port of Baltimore for specific "benchmark" years and contributed to the establishment of the "without project" condition. The simulation model also served as the tool by which various alternative deepwater improvements were evaluated.

During execution of the many simulation runs, model output indicated that the port system experienced inordinate delays in moving the projected vessels through the system in the year 2030 timeframe. It was determined that known infrastructure and productivity rates (both existing and planned) would not satisfactorily accommodate the tonnages and vessels forecast for the Port after the year 2030 (all other infrastructure elements remaining the same). For this reason, the evaluations utilizing these forecasts conducted by the Baltimore District Corps of Engineers excluded consideration of commodity and vessel traffic growth reflected in the unconstrained forecasts for the years 2040 and 2050. Chart 1 illustrates the forecast process.

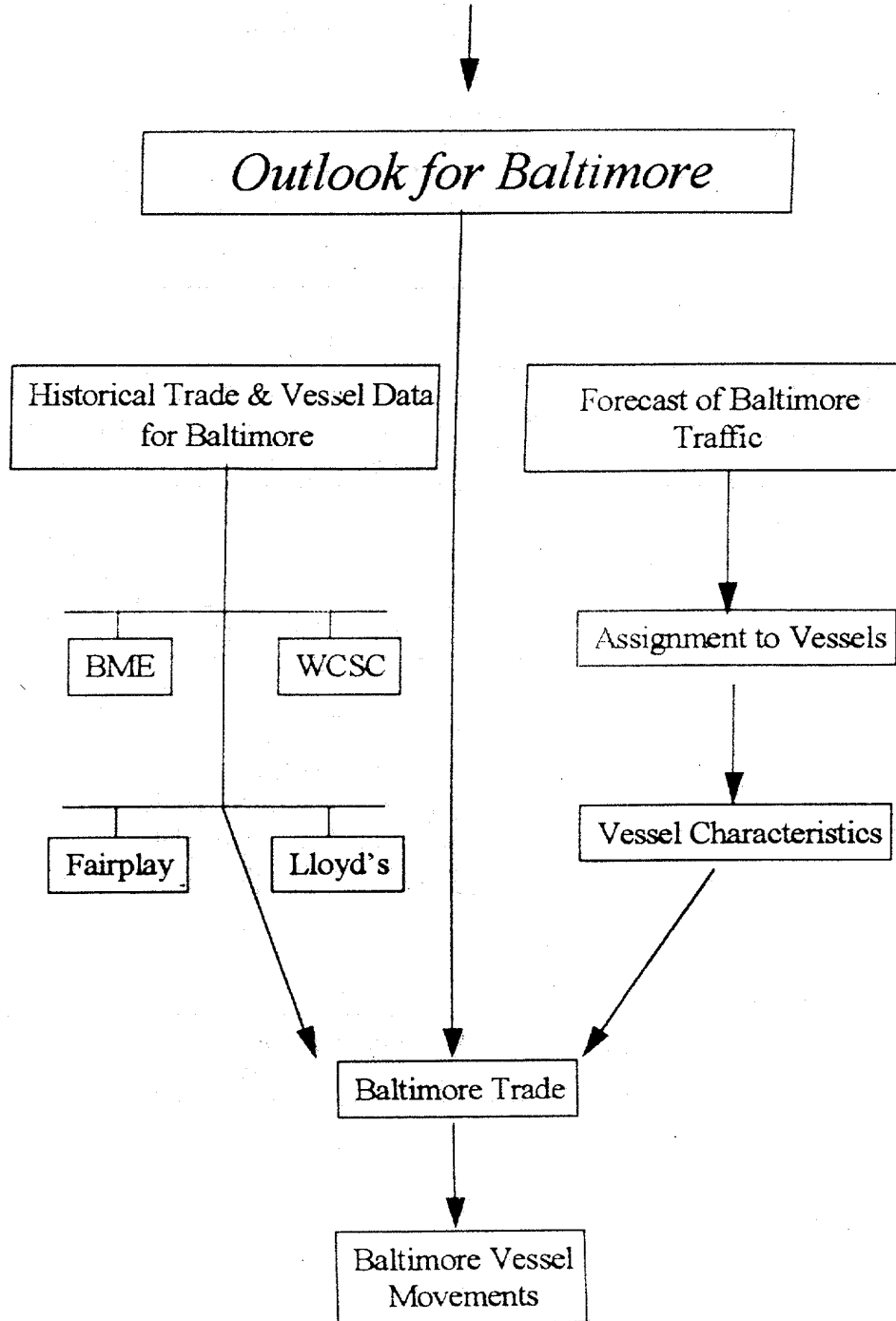
**CHART 1**  
**DRI'S FORECAST PROCESS**  
*... begins globally ...*



Continued . . .

CHART 1 (cont'd)

... and finishes locally...



### **Assumptions Used in the Forecast Process**

Forecast assumptions used in this project essentially fall into two categories: those relating to the port and transportation and those economic in nature that drive the trade forecast.

#### *Transportation & Port-Level Assumptions*

The forecast model is demand driven, that is, it assumes that there will be the capacity in place to handle the trade (demand) projected and does not specifically address supply issues. It also assumes that each portion of the current mix of traded commodities and partners will increase at the projected growth rate. The forecast does not assume changes in the port's market area. It is the fully forecasted total U.S. outlook and each port's relative share that drives projected port figures. Ports will therefore have different outlooks because of their different trade concentration (commodity and partner) based on the different growth rates each commodity and partner is expected to have at the national level. The mapping of cargo to types of vessels is based on the cargo carried on specific vessels and voyages in the base period.

#### *Economic Assumptions used in the Trade Model*

Assumptions underlying the cargo and fleet forecast are based on detailed forecasts of the U.S. and global economies. At the time of the forecast in March 1995, many of the major economies were grappling with periods of slow growth or recession, and unlike the United States, most had yet to experience a sustained recovery. On the other hand, many of the newly industrializing regions of Latin America and Asia were growing strongly. Because Baltimore trades heavily with Europe, Europe's recession impacted the outlook for Baltimore. In other words, the recessions that occurred in the industrialized countries between 1991 and 1994 impacted the forecast for Baltimore due to the significant proportion of Baltimore trade represented by trade with Europe and the impact of the declines in those markets on the base

trade levels for Baltimore. At the same time, the declines in the European trades overshadowed the strong growth in trade with developing markets in Latin America and Asia. While the WSTS forecasts are based on forecasts for each commodity traded with each of the individual trade partners, the magnitude of the European trades and the short term declines in key commodities in that trade had a significant effect on the base Baltimore trade levels and, as has been discussed, while WSTS forecasts growth in those significant commodity flows, the pace of recovery was ultimately faster than the growth projected.

#### *Short-Term Outlook -- 1990-1996*

After a period of strong economic growth in the late 1980s, expansion of world economic activity, especially among the industrial countries, was disappointing in the mid-90s. Since 1990 the world economy's growth had averaged under 2 percent, and unemployment in the major developed countries had risen.

Overall world growth was hampered by a desynchronized recession in the industrialized countries. Recessionary pressures had been building for some time due to asset deflation and high debt levels, but the downturn was triggered by the August 1990 Iraq-Kuwait conflict and the consequent rise in oil prices. In some economies, such as the U.S., U.K., Canada and Australia, these developments destroyed the confidence of consumers and businesses, a confidence that had allowed them to shrug off the impact of rising interest rates during the late 1980s. The downturn that followed was sharp, drastically cutting average growth in 1990 and leading to sharp falls in output in 1991.

The recession in output growth in Europe did not begin until the middle of 1992 and continued through the start of 1994. High rates of inflation in Germany, triggered by the heavy cost of reunification of the two Germanys, led to a succession of rate hikes, which were passed on through the exchange rate mechanism to other countries. As a result, growth slowed through 1993 and 1994. In the next few years, the forecast analysis indicates that

world growth will again accelerate slowly. Demand growth will continue to accelerate in most of the industrialized countries during 1994-95, while the newly industrializing and developing economies will continue to show strong growth that is often 3 to 4 percent higher, in real terms, than the industrialized economies. Although the gap between industrial and developing country growth rates is expected to narrow over the next few years as the industrialized countries recover, it still will be significant. This higher growth path is sustainable, particularly in Asia and much of Latin America, because of higher savings rates, higher investment, rising domestic consumption levels due to rising income, and increased export competitiveness among themselves and with the industrial countries.

In 1995, Europe and Japan were expected to continue their recovery buoyed by lower interest rates and rising consumer demand. The U.S., however, will exhibit slower growth as Federal Reserve tightening dampens the strength of the economic recovery. The result of all these changes is that U.S. export growth should be faster and U.S. import growth slower in 1995.

#### *The Medium Term Outlook, 1997 - 2000*

In determining the outlook for the world economy until the end of the century, our analysis focuses on two key aspects:

1. The likely extent of any spare capacity in the world economy and its affect on inflation, interest rates and, hence, potential economic activity,
2. The expansion of potential supply coming from increased labor availability, rising capital stock and technological improvement.

In the industrialized countries, growth over the next few years is unlikely to be fast enough to remove all the current large overhang of spare capacity. Despite economic recovery, continual debt overhang and government deficits will moderate the speed of the recovery. Moreover, unemployment will continue to be high, especially in Europe. At the same time,

the existence of this spare capacity means that inflation will remain subdued. The combination of spare capacity and low inflation will allow output growth to outpace capacity growth over the latter part of the 1990s.

It is useful to put the forecast for capacity growth into a historical context. During the long expansion, which lasted from 1982 to 1991, the world economy grew at an average rate of 3.2 percent. Over the 1996 to 2000 period, world economic capacity is projected to grow at around 3.3 percent a year -- very near the performance during the 1980s expansion. In supply-side terms, this growth comes from various sources. The contribution from the capital stock is slightly higher as investment rates have improved. However, contribution from labor is falling as world population growth slows, while the contribution from technological progress remains around 1 percent a year. While this represents the world average, it is important to note the significant difference between the growth tracks of the average mature industrial economy (about 2 to 2-1/2%) and the more successful developing economies (5-6% per year).

The growth projections represent the most likely scenarios, but it is important to consider which downside risks may alter these scenarios. Two sets of assumptions are most critical. First, as noted in more detail later, oil prices (and associated energy prices) are assumed to grow moderately without significant disruption. A detailed examination of demand and supply conditions support this as the most likely outcome. Second, it is assumed that trade conditions under a concluded GATT will, in general, continue to improve. While bilateral trade disputes are inevitable, no significant rise in protectionism between the U.S. and Europe and Asia is assumed in this forecast. Clearly, a significant trade war or protectionist movement would lower the outlook for trade growth, but this remains as a less probable risk at the time of this analysis.

Traditionally, a one percent expansion in world output has been accompanied by a more than 1 percent increase in world trade, where a 3 percent economic growth normally led to a 5 to 6

percent growth in trade. This trend is expected to continue over the medium and long term. Over the 1996 to 2000 period, world trade volumes are projected to expand by 5.7 percent a year, over one and a half times as fast as the rise in world output.

#### *The Long Term Outlook -- 2001-2050*

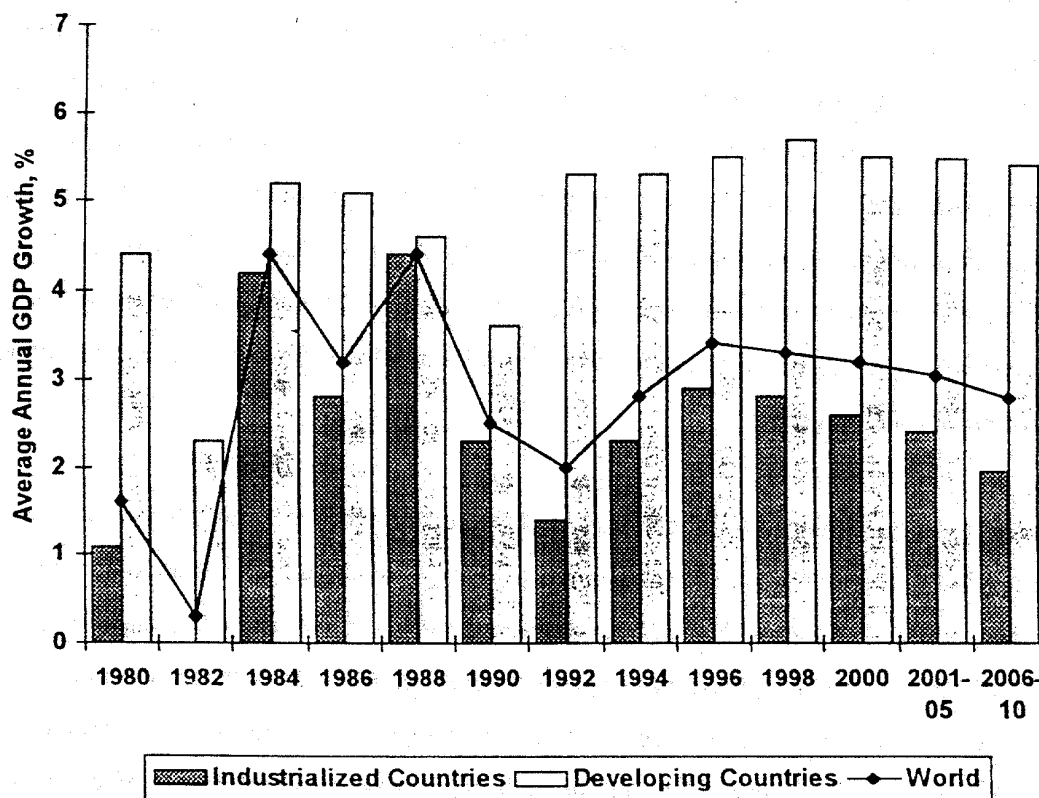
In the first decade of the 21st century, overall economic growth is expected to moderate to approximately three percent per year. Compared with the previous five years, the contribution from labor is lower, as population growth is slowly declining, while in the industrialized countries, participation rates (the proportion of the population enrolled in the labor force) are stabilizing after a long period of trend increase. Slower growth in the labor force causes world investment levels to increase as firms replace labor with capital. This maintains growth in the capital stock and helps maintain the expansion of world economic capacity, and given the significance of capital goods trade to the United States, insures relatively strong growth in U.S. exports well into the next century. Supported by rising investment, the contribution from technological progress remains close to one percent a year, although total factor productivity growth in this period is beginning to be slowed by the elimination of the easiest cases of technological catch-up. Asia is still expected to provide most of the leading growth economies, although some successfully transformed areas of Eastern Europe should be showing rapid improvement as they slowly integrate economically into the European market.

Trade growth within this context can be expected to moderate slightly on an overall basis. Much of the impetus for rapid trade growth in the 1980s and 1990s was due to liberalization and marketization trends that will have reached maturity. Moreover, the gap between trade growth and economic growth will narrow as foreign investment substitutes local production for exports in many regions. As a natural consequence, trade cannot continue to expand indefinitely as a percentage of economic activity. Given the significant number of factors that

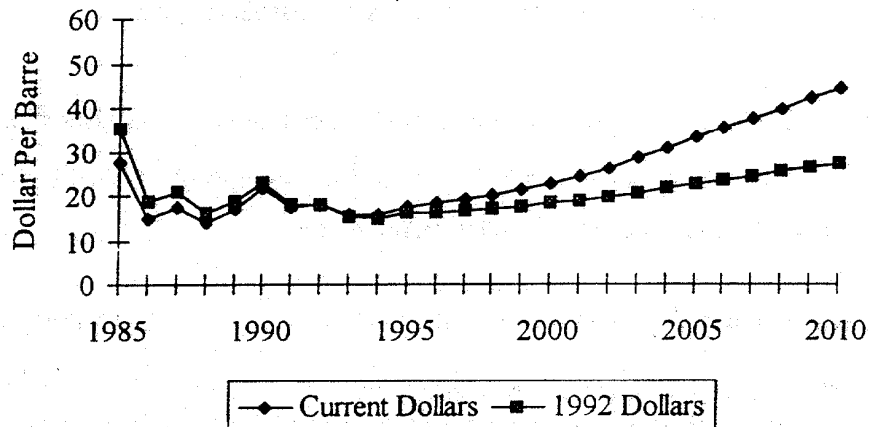
do encourage cross border interactions, however, this narrowing of the trade and economic growth gap can be expected to be quite gradual.

Within the context of differing patterns of growth are underlying assumptions and forecasts that relate to the larger economic, political and social factors that shape the development of the world economy. Key factors include moderate increases in crude oil prices, a continuation in the pace of reform and positive regionalization of global trade and economic activity. The following charts illustrate some of the economic trends.

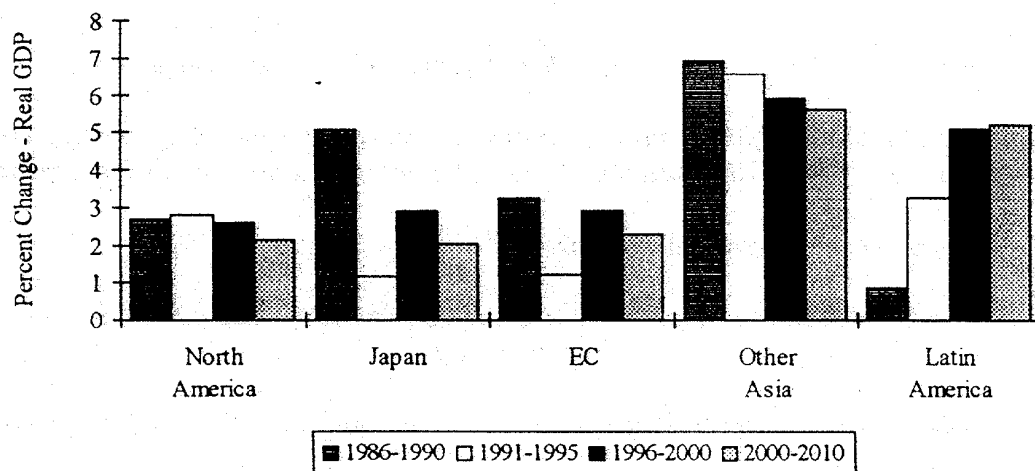
**CHART 2**  
**WORLD ECONOMY MOVING OUT OF**  
**SLOW GROWTH PHASE**



**CHART 3**  
**WORLD CRUDE OIL PRICES REFLECT**  
**MODERATE DEMAND GROWTH**



**CHART 4**  
**PROJECTED ECONOMIC GROWTH BY REGION**



## Risk & Uncertainty Factors

Based on the information about current and future trade and vessel patterns as specific as those for Baltimore, the Army Corps can effectively evaluate Baltimore's problems associated with its limited anchorages, circuitous channels and associated hazards.

As with any forecast, there are risks and uncertainties that could be associated with any of the DRI models used or for that matter with any of the assumptions or any piece of underlying data. Some of the more general risk elements include:

1. Alternative outlooks for U.S. regional activity that could affect port activity  
*the U.S. North Atlantic coast was growing more slowly than other U.S. regions, particularly noticeable was the relatively slow trade growth from the North Atlantic region.*
2. Alternative international growth scenarios could affect port activity  
*had growth been better in Europe in 1992 through 1994, the conservative base volumes and trade volumes projected would have been higher in Baltimore*
3. Port may not maintain constant share of coastal trade at historic levels  
*the base WSTS forecasts for the Port of Baltimore assume maintenance of the base historic port share of the North Atlantic Coast. This could be altered in different scenarios*
4. Alternative local industrial specialization  
*a different industrial emphasis in a local region may affect its commodity mix & thus trade*
5. Marketing by the port to attract new trade or by competitors could affect commodity mix  
*e.g., Norfolk could arrange competitive inland rates to attract Pennsylvania's coal from Baltimore*

6. Port technology and availability of inland transportation facilities (trains, roads, etc)  
*capacity is assumed available to handle the demand (refer to Annex G for information on Port of Baltimore capabilities)*
7. Underlying assumptions linking cargo to specific vessels.  
*alternative changes in vessel technology and/or size may be tested. The baseline forecasts are based on the WFFS forecasts by vessel type.*
8. Conservative forecast means remaining risk on greater cargo and traffic is higher  
*Because the forecast of Baltimore's exports conservatively included growth in key markets that declined in the 1993/1994 overseas recessions and did not incorporate short term recoveries of the magnitude that have since occurred, the probability or risk of future market levels falling short of the forecasts is less than the probability that future markets will exceed the forecast.*
9. Oil prices (and associated energy prices) are assumed to grow moderately without significant disruption  
*Gulf War triggered oil price rise*
10. Trade conditions assumed to continue to improve (under GATT)  
*a trade war or protectionist measures would lower trade outlook*

### **Major Commodities Forecast**

Baltimore handled 23 million metric tons of foreign cargo in 1993. By 1995 the volume of the international cargo handled in Baltimore was forecasted to increase to 25 million metric tons. (Actual foreign tonnage through the Port of Baltimore in 1995 totaled 28 million metric tons.) Both economic growth abroad and continued economic growth in the U.S. (locally and in the U.S. mid-West) were believed to spur this growth. Much of this tonnage is from bulk commodities. Outbound the largest export by far is coal -- much of it used to generate electricity in Europe and Japan. Inbound, historically iron ore (much of it from Canada and Brazil) tops the imports by weight, but the product mix is more diverse than outbound. By

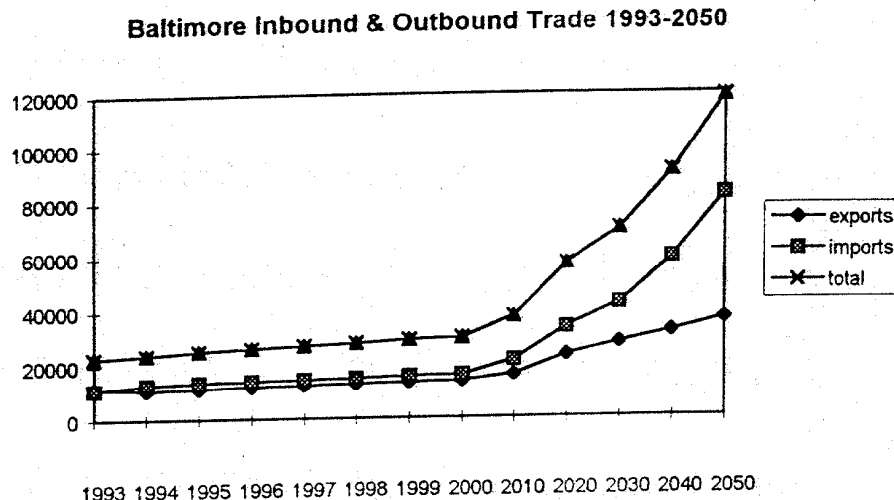
2000, it was estimated that foreign cargo handled would grow to 29 million metric tons and to 56 million metric tons by 2020. The 2050 forecast figures show increased trade strength, with the volume of foreign trade up to 118 million metric tons as reflected in Table 1.

The relationship between outbound and inbound foreign cargo flows has changed over time (see Chart 5). In the early 90s, exports exceeded imports in tonnage terms. In 1993, the amount of exports to imports was almost the same as export cargoes declined. In 1994 Baltimore's imports grew rapidly, especially iron ore imports from Brazil, while exports fell, particularly in grains. This created a trade imbalance for Baltimore that year in which exports represented only 84 percent of imports total tonnage. Because that imbalance occurred historically, the (port share of the coast) forecast method employed for the port of Baltimore conservatively carried that imbalance and the lower exports into the forecast. In 1995, exports were expected to be 86 percent of imports. By 2010, exports were projected to be just 75 percent of total imports and by 2020, 70 percent of imports. The release of subsequent historical data, however, shows 1995 foreign trade for Baltimore in virtual balance -- about 13 million metric tons in each direction (with increases particularly noticeable in grain and coal exports by 1995). The increase in exports in 1995 would increase the projected volumes and reduce the projected imbalances. The forecast used for the "without project" analysis, therefore, was and continues to be a conservatively low projection of future volumes through the Port of Baltimore since the recent figures indicate projected import tons are likely to be achieved while the recovery in exports indicate export flows will exceed projected levels.

**CHART 5**

**PORT OF BALTIMORE TOTAL FOREIGN TRADE,  
INBOUND AND OUTBOUND FOR 1993-2050**

Based on 000s metric tons



Source: DRI/Mercer World Sea Trade Service, 95Q1 forecast

The commodity profile of Baltimore's foreign cargo in tonnage terms is projected to continue to closely resemble its historical patterns. The commodity detail available for Baltimore based on the 40 WSTS commodities is shown in Table 1. Bulk commodities especially will remain a significant portion of this trade's total tonnage.

Referring to Table 1, commodities are listed in decreasing order for the total trade for the Port of Baltimore for 1993 - 2050. As indicated, bulk commodities dominate by total metric tons, however growth rates for cargoes will vary; many non-bulk products will expand far more rapidly than bulk products. For example, healthy growth rates exist in auto parts/motorcycles, light industrial machinery, heavy transportation equipment, and pharmaceuticals.

**TABLE 1**  
**TOTAL FOREIGN TRADE FOR PORT OF BALTIMORE FROM 1993-2050**  
Commodities in Metric Tons, Growth Rates on Compounded %

Commodity	1993	2000	2010	2020	2030	2040	2050	1993-2000 Growth Rates	2000-2010 Growth Rates	2010-2020 Growth Rates	2020-2030 Growth Rates	2030-2040 Growth Rates	2040-2050 Growth Rates
(19) Coal & Coke	8,615,467	9,901,954	9,393,883	14,035,105	15,538,891	16,026,129	15,785,893	2.01	-0.53	4.10	1.02	0.31	-0.15
(16) Iron Ore	3,279,103	4,386,735	5,240,671	8,267,596	7,828,333	17,697,801	17,614,444	4.24	1.79	4.66	-0.54	4.10	4.18
(14) Cement, Lime & Stone	2,004,274	3,309,275	5,400,544	8,791,689	11,476,596	15,015,994	19,597,564	7.43	5.02	4.99	2.70	2.72	2.70
(4) Grain	1,389,019	1,434,750	2,055,866	2,008,112	1,816,502	1,561,411	1,317,153	0.46	3.66	-0.23	-1.00	-1.50	-1.69
(8) Oilseeds	966,008	809,054	721,731	705,321	648,666	616,736	603,596	-2.50	-1.14	-0.23	-0.83	-0.50	-0.23
(21) Petroleum Products	729,667	1,177,846	1,720,310	3,069,924	5,075,684	7,857,586	11,485,117	7.08	3.86	5.96	5.16	4.47	3.87
(5) Sugar	617,242	585,544	508,649	1,283,067	1,835,225	2,195,840	2,589,102	-0.75	-1.40	9.69	3.64	1.81	1.66
(30) Iron & Steel	606,644	1,004,240	1,265,980	1,778,625	1,982,594	2,231,765	2,587,102	7.47	2.34	3.46	1.09	1.19	1.49
(17) Bauxite & Oth. Base Metal Ores	462,121	420,276	546,647	750,117	1,022,585	1,379,355	1,739,962	-1.35	2.66	3.21	3.15	3.04	2.35
(35) Passenger Cars	366,141	624,513	1,122,153	1,130,271	1,374,247	1,738,621	2,175,244	7.93	6.04	0.07	1.97	2.50	2.15
(12) Pulp & Waste Paper	332,362	646,871	1,318,041	1,544,201	1,229,279	1,525,138	1,871,355	9.79	7.38	1.60	-2.25	2.18	2.07
(24) Other Chemicals	311,874	474,026	703,579	936,996	1,457,414	2,319,441	3,489,554	6.16	4.03	3.23	1.40	1.05	0.76
(11) Lumber & Wood	305,124	564,482	903,416	1,885,932	2,850,911	4,148,697	5,964,698	9.19	4.82	7.64	4.22	3.82	3.70
(34) Heavy Trans. Equip.	268,568	494,522	820,415	1,733,020	2,979,402	4,661,431	6,901,417	9.11	5.19	7.76	4.58	4.58	4.00
(31) Non-Ferrous Metals	241,271	341,307	490,570	728,574	960,405	1,336,263	1,924,621	5.08	3.69	4.03	2.80	3.36	3.72
(6) Food Products	235,033	353,581	514,196	971,082	1,538,398	2,405,344	3,622,146	6.01	3.82	6.56	4.71	4.57	4.18
(39) Consumer Goods	210,514	286,503	370,939	450,873	553,281	669,059	836,033	4.50	2.62	1.97	2.07	1.92	2.25
(18) Other Ores & Scrap	203,731	282,116	381,045	640,600	1,145,443	1,961,129	3,145,509	4.76	3.05	5.33	5.98	5.52	4.84
(33) Light Industrial Mach.	185,149	269,904	408,057	675,412	1,188,673	1,882,484	2,740,291	5.53	4.22	5.17	5.82	4.70	3.83
(28) Paper	162,545	260,958	455,887	689,028	870,821	1,087,022	1,349,803	7.00	5.74	4.22	2.37	2.24	2.19
(28) Plastics & Chemical Prod.	154,238	237,683	305,382	610,418	897,959	1,336,819	1,963,523	6.37	2.54	7.17	3.94	4.06	3.92
(3) Fruits & Vegetables	124,979	177,568	228,399	412,033	523,381	666,041	826,104	5.15	2.55	6.08	2.42	2.44	2.18
(36) Auto Parts/Motorcycles	119,500	196,948	321,670	394,414	624,287	1,039,071	1,784,228	7.40	5.03	2.06	4.70	5.23	5.56
(32) Heavy Industrial Machinery	111,283	180,371	305,571	364,179	398,008	429,018	469,742	7.14	5.41	1.77	0.89	0.75	0.91
(2) Meat, Fish & Dairy Products	109,029	179,670	306,281	570,994	782,092	1,050,866	1,433,401	7.40	5.48	6.43	3.20	3.00	3.15
(15) Manufactured Fertilizers	92,747	212,797	357,546	435,386	512,615	643,964	782,399	12.60	5.33	1.99	1.65	2.31	1.97
(10) Rubber	82,283	93,125	107,067	112,228	129,284	120,511	115,518	1.78	1.40	0.47	1.42	-0.70	-0.42
(38) Electrical Equipment	76,593	138,269	240,953	371,842	542,849	776,271	1,091,713	8.80	5.71	4.43	3.86	3.64	3.47
(27) Textile, Leather & Rubber Mils	74,806	121,281	175,175	291,782	427,802	597,385	820,218	7.15	3.75	5.23	3.90	3.40	3.22
(7) Textile Fibers, Hides	45,898	43,018	50,476	58,345	62,209	60,746	60,106	-0.92	1.61	1.46	0.64	-0.24	-0.11
(40) Commodities, NES	43,856	46,366	52,991	86,130	131,999	168,043	226,625	0.80	1.34	4.98	4.36	2.44	3.04
(25) Pharmaceuticals	25,759	39,462	76,805	123,719	187,323	284,669	410,500	6.28	6.89	4.88	4.24	4.27	3.73
(23) Liquid Bulk Chemicals	11,832	10,878	12,345	17,390	25,122	39,435	61,266	-1.19	1.27	3.49	3.75	4.61	4.50
(9) Oils & Fats	7,811	10,375	18,012	28,642	31,879	34,952	38,306	4.14	5.67	4.75	1.08	0.92	0.92
(37) Aircraft & Ships	5,580	7,081	10,680	14,667	17,550	22,931	30,144	3.46	4.20	3.22	1.81	2.71	2.77
(20) Crude Petroleum	46	18	18	0	0	0	0	-12.54	0.00	NA	NA	NA	NA
(22) Natural & Manufactured Gas	33	20	21	108	393	814	1,271	NA	NA	NA	NA	NA	NA
(1) Live Animals	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(13) Phosphates	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTALS	22,906,312	29,788,496	37,512,597	56,936,648	69,781,678	90,845,028	118,789,561	3.82	2.33	4.26	2.06	2.67	2.72

Source: DRJ/Mercer World Sea Trade Service, 95Q1 forecast

When total foreign trade is reviewed by direction, Baltimore's outbound cargo is characterized by large bulk moves of coal and coke, oil seeds, and grain.

**TABLE 2**  
**BALTIMORE'S TOP FOREIGN OUTBOUND COMMODITIES**  
**(in thousand metric tons)**

Commodity	1993	2000	2010	2020	2030	2040	2050
Coal & Coke	7,561	8,893	8,750	13,474	15,018	15,454	15,136
Oil Seeds	965	809	722	705	648	616	601
Grain	1,368	1,411	2,013	1,954	1,766	1,513	1,268
Total of Above	9,894	11,113	11,485	16,133	17,432	17,583	17,005
TOTAL	11,644	13,748	16,154	23,310	27,640	31,759	36,358
<b>Growth Rates (%)</b>							
Coal & Coke		2.35	-0.16	4.41	1.09	0.29	-0.21
Oil Seeds		-2.49	-1.13	-0.24	-0.84	-0.51	-0.25
Grain		0.44	3.62	-0.30	-1.01	-1.53	-1.75
Total		2.40	1.63	3.74	1.72	1.40	1.36

Source: DRI/Mercer World Sea Trade Service, 95Q1 forecast

Table 2 indicates the prominence of these three dry bulk items, showing that their total tonnage was 85 percent of total foreign tonnage exported in 1993. Over time the forecast projected these bulk commodities to decline in importance to 81 percent of Baltimore's exports by weight in 2000 and 69 percent in 2020.

The trade in these commodities through Baltimore was not forecasted to grow rapidly over the years. By the year 2000, these commodities were expected to exhibit a modest average decline of 2 percent. A generally negative trend was expected to continue in the following decade, as tonnage of oilseeds and grain declined. Coal tonnage would double by 2030 and then stabilize through 2050 at 15 million metric tons.

This forecast was impacted by a drop in U.S. exports of coal in 1993 that continued into 1994. This included almost all export markets from Europe and the Far East and a large

portion of these exports would have been handled in Baltimore. The U.S. outlook called for improved exports (in the 5% range) the next year even as Australia was increasing its coal exports. In fact, U.S. coal exports were much stronger than expected and Baltimore's exports alone increased to 11.97 million metric tons in 1995 (above the historical 1991-92 levels).

Baltimore's coal exports to Northern Europe, where Germany's steel industry has been hurt by its slowing economy and by a drop in demand for steel by neighboring European countries, were expected to decline by -0.72 percent in the years 1993 to 2000. However, growth rates move upward by the year 2020, based on the assumption that Northern Europe's main economies continue to have a longer-term growth trend and that there will be no increase in trade barriers.

A change in technology is impacting the coal trades. Steel made in electric furnaces does not require coal. In general, demand for cooking coal is declining as the use of a technology called pulverized coal injection increases. Thus, the demand for metallurgical coals for steel making is flat while coal used to make electricity is growing. On a cautionary note, one must continue to monitor environmental developments in Europe aimed at reducing carbon dioxide emissions that could ultimately affect imports from the U.S.

Baltimore's grain exports were expected to remain basically steady through 2000 in the 1.4 million metric ton range, with growth resuming after 2000 through 2010. The years after 2010 (to 2050) will see small declines, based on growth in alternative global grain sources.

TABLE 3

## GROWTH OF BALTIMORE'S TOP OUTBOUND COMMODITIES

(in thousand metric tons)  
(compound annual growth rates - %)

	1993	2000	2010	2020	2030	2040	2050	1993-2000 Growth Rates	2000-2010 Growth Rates	2010-2020 Growth Rates	2020-2030 Growth Rates	2030-2040 Growth Rates	2040-2050 Growth Rates
19) Coal & Coke	7,561,965	8,893,999	8,750,879	13,474,260	15,018,240	15,454,050	15,136,310	2.34	-0.16	4.41	1.09	0.29	-0.21
4) Grain	1,368,648	1,410,898	2,013,735	1,954,292	1,766,817	1,513,019	1,268,061	0.44	3.62	-0.30	-1.00	-1.54	-1.75
8) Lumber	963,725	808,809	721,955	704,973	647,999	615,656	600,949	-2.50	-1.13	-0.23	-0.84	-0.51	-0.24
11) Lumber & Wood	262,111	375,090	549,864	766,244	887,529	1,006,405	1,096,868	5.25	3.90	3.37	1.48	1.26	0.86
26) Plastics & Chemical Prod.	123,274	183,200	295,957	443,957	612,440	802,585	1,020,604	5.82	4.91	4.14	3.27	2.74	2.43
35) Passenger Cars	119,306	272,664	726,365	883,574	1,254,373	1,690,056	2,128,693	12.53	10.29	2.00	3.54	3.03	2.33
24) Other Chemicals	108,946	158,636	249,388	454,994	807,538	1,392,253	2,150,724	5.51	4.63	6.20	5.90	5.60	4.44
34) Heavy Trans Equip	89,389	135,251	241,406	408,709	596,082	821,830	1,070,633	6.09	5.96	5.41	3.85	3.26	2.68
39) Consumer Goods	88,594	135,170	235,790	444,417	746,095	1,132,240	1,688,025	6.22	5.72	6.54	5.32	4.26	4.07
33) Light Industrial Mch.	87,310	109,618	178,316	325,356	571,475	895,047	1,345,434	3.30	4.99	6.20	5.79	4.59	4.16
28) Paper	85,428	112,857	166,407	297,956	452,924	638,159	877,524	4.06	3.96	6.00	4.28	3.49	3.24
30) Iron & Steel	82,476	114,142	197,980	381,243	541,161	741,802	1,014,466	4.75	5.66	6.77	3.56	3.20	3.18
29) Other Min. & Metal Manu.	78,387	131,358	257,352	389,178	573,343	869,658	1,276,821	7.65	6.96	4.22	3.95	4.25	3.91
6) Food Products	67,823	119,535	231,017	311,319	358,432	421,565	505,850	8.43	6.81	3.03	1.42	1.64	1.84
32) Heavy Industrial Machinery	49,150	66,755	122,261	164,614	197,709	217,132	239,350	4.47	6.24	3.02	1.85	0.94	0.98
21) Meat, Fish & Dairy Products	48,874	106,056	213,725	359,163	492,358	649,362	878,142	11.70	7.26	5.33	3.20	2.81	3.06
31) Non-Ferrous Metals	47,726	49,247	52,402	123,150	205,247	331,264	545,922	0.45	0.62	8.92	5.24	4.90	5.12
12) Pulp & Waste Paper	46,605	63,120	110,521	175,551	142,294	186,285	276,739	4.43	5.76	-4.74	-2.08	2.73	4.04
36) Auto Parts/Motorcycles	45,899	78,087	164,034	180,120	214,013	232,964	328,722	7.89	7.70	0.94	1.74	1.69	2.65
38) Electrical Equipment	41,393	67,431	119,479	206,741	335,831	505,818	742,402	7.22	5.89	5.64	4.97	4.18	3.91
18) Other Ores & Scrap	35,778	31,898	58,963	82,628	79,297	62,037	51,763	-2.01	6.34	3.43	-0.41	-2.42	-1.79
14) Cement, Lime & Stone	35,892	66,325	123,026	153,591	193,215	237,096	303,137	9.17	6.37	2.24	2.32	2.07	2.49
7) Textile Fibers, Ylides	34,831	31,723	40,218	47,782	51,838	50,156	50,156	-1.33	2.40	1.74	0.82	-0.23	-0.10
21) Petroleum Products	32,494	42,973	53,081	139,461	267,597	436,052	640,673	4.07	2.13	10.14	6.73	5.00	3.92
40) Commodities, NES	32,449	31,022	28,826	57,761	100,039	132,014	182,928	-0.64	-0.73	7.20	5.65	2.81	3.32
27) Textile, Leather & Rubber Mills	25,051	35,290	51,085	81,212	111,264	137,120	174,100	5.02	3.77	4.74	3.20	2.11	2.42
25) Pharmaceuticals	20,878	32,873	68,900	112,238	172,202	264,582	383,131	6.70	7.68	5.00	4.37	4.39	3.77
10) Rubber	17,382	23,575	34,415	37,971	53,280	56,701	63,349	4.45	3.86	0.99	3.45	0.62	1.11
3) Fruits & Vegetables	13,042	20,515	30,278	46,661	68,925	94,639	127,087	6.69	3.97	4.42	3.98	3.22	2.99
17) Bauxite & Oth. Base Metal Ores	8,960	16,685	27,159	41,043	44,760	48,232	52,248	9.29	4.99	4.22	0.87	0.75	0.80
23) Liquid Bulk Chemicals	6,786	7,602	10,012	14,065	19,515	29,416	45,600	1.64	2.79	3.46	3.33	4.19	4.48
37) Aircraft & Ships	5,309	6,603	9,881	13,350	15,932	20,959	27,613	3.17	4.11	3.05	1.78	2.78	2.80
5) Sugar	4,481	7,900	16,688	27,454	37,474	49,164	61,071	8.44	7.76	5.10	3.16	2.75	2.19
9) Oils & Fats	1,301	2,006	3,379	3,564	3,033	2,500	2,066	6.38	5.35	0.53	-1.60	-1.91	-1.89
20) Crude Petroleum	46	18	18	0	0	0	0	-12.54	0.00	0.00	0.00	0.00	0.00
22) Natural & Manufactured Gas	33	20	21	108	393	814	1,271	-6.90	0.49	17.79	13.79	7.55	4.56
15) Manufactured Fertilizers	0	0	0	0	0	0	0	0	0	0	0	0	0
1) Live Animals	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
13) Phosphates	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
16) Iron Ore	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTALS	11,646,735	13,750,951	16,156,437	23,312,720	27,642,694	31,761,167	36,360,502	2.40	1.63	3.73	1.72	1.40	1.36

Source: DRI/Mercer World Sea Trade Service, 95Q1 forecast

Manufactured products (although a much smaller portion of the tonnage) are expected to show significant growth over time. Table 3 indicates that Baltimore's finished goods exports will grow within a range of 6 to 10 percent a year through 2010 with a few categories of manufactured products growing at an increased pace to 2050. Automobile exports are expected to grow very rapidly through 2010 as U.S. exports and auto production increase to meet global demands.

Many of the fastest growing export commodities would be included among intermodal cargo. On the inbound side, Baltimore's imports will grow overall at a slow, but continuous, pace. By 2010, they will have again reached the levels of the late 1980s in tonnage terms. Typical bulk and tanker products will remain an important part of this trade. Together bulk and tanker cargo will maintain approximately 73 percent of the trade in tonnage terms, although there is a short-term decrease to about 71 percent in 2000.

**TABLE 4**  
**BALTIMORE'S TOP FOREIGN IMPORT COMMODITIES**  
(in thousand metric tons)

Commodity Category	1993	2000	2010	2020	2030	2040	2050
Cement, Lime, & stone	1,968	3,242	5,277	8,638	11,283	14,778	19,294
Iron Ore	3,279	4,386	5,240	8,267	7,828	11,697	17,614
Petroleum Products	649	1,134	1,667	2,930	4,808	7,421	10,844
Coal & Coke	1,053	1,007	643	561	521	572	651
<u>Total of Above</u>	6,949	9,769	12,827	20,396	24,440	34,468	48,403
<b>Total of all Commodities</b>	11,260	16,037	21,436	33,623	42,139	59,083	82,429

*Source: DRI/Mercer World Sea Trade Service, 95Q1 forecast*

Increased imports of both cement (mainly from Canada) and petroleum products (increasingly from Venezuela and Trinidad and Tobago) reflect the positive outlook for the U.S. economy over this period in general. As is true for most of the United States, Baltimore's imports of iron ore from Canada, are expected to continue to fall, but imports from Latin America (especially Brazil) will increase.

**TABLE 5**  
**BALTIMORE'S INBOUND FOREIGN COMMODITIES: GROWTH RATES**  
 ((in thousand metric tons)  
 (compound annual growth rates - %)

Commodity	1993	2000	2010	2020	2030	2040	2050	Growth Rates 1993-2000	Growth Rates 2000-2010	Growth Rates 2010-2020	Growth Rates 2020-2030	Growth Rates 2030-2040	Growth Rates 2040-2050
16) Iron Ore	3,279,103	4,386,735	5,240,671	8,267,596	7,828,333	14,778,900	17,614,444	4.24	1.79	4.66	-0.54	4.10	4.18
14) Cement, Lime & Stone	1,968,382	3,242,949	5,273,518	8,638,098	11,283,380	19,294,430	19,294,430	7.39	4.99	5.05	2.71	2.74	2.70
19) Coal & Coke	1,053,502	1,007,955	643,004	360,843	520,647	572,076	650,578	-0.63	-4.40	-1.36	-0.74	0.95	1.29
21) Petroleum Products	697,173	1,134,872	1,667,229	2,930,463	4,808,087	7,421,514	10,844,440	7.21	3.92	5.80	5.08	4.44	3.87
5) Sugar	612,761	577,644	491,961	1,255,613	1,797,751	2,146,676	2,528,800	-0.84	-1.59	9.82	3.65	1.79	1.65
30) Iron & Steel	524,168	890,098	1,068,000	1,397,382	1,441,433	1,489,963	1,572,616	7.86	1.84	2.72	0.31	0.33	0.54
17) Bauxite & Oth. Base Metal Ores	453,161	403,591	519,488	709,075	977,826	1,331,123	1,687,715	-1.64	2.56	3.16	3.27	3.13	2.40
12) Pulp & Waste Paper	285,757	583,751	1,207,520	1,368,650	1,086,986	1,338,583	1,594,616	16.52	7.54	1.26	-2.28	2.10	1.77
35) Passenger Cars	246,835	351,849	395,788	244,697	119,974	68,564	46,551	5.19	1.18	-4.59	-6.88	-5.44	-3.80
31) Non-Ferrous Metals	220,842	445,275	768,014	1,609,870	2,774,155	4,330,167	6,355,495	10.54	5.60	7.68	5.59	4.55	3.91
34) Heavy Trans. Equip.	215,735	429,231	662,010	1,477,223	2,254,829	3,326,867	4,894,065	10.33	4.43	9.29	3.43	3.97	3.94
18) Other Chemicals	173,736	304,473	349,229	482,002	649,876	927,188	1,338,830	5.22	1.38	3.27	3.03	3.62	3.74
6) Food Products	173,448	221,773	259,553	311,976	473,984	607,032	784,270	5.61	2.05	1.67	2.56	2.50	2.59
39) Consumer Goods	146,439	221,773	259,553	311,976	473,984	607,032	784,270	5.61	2.05	1.67	2.56	2.50	2.59
33) Light Industrial Mach.	116,421	172,498	202,729	365,372	573,968	1,273,104	1,934,121	5.88	2.46	6.58	4.17	4.86	4.27
3) Fruits & Vegetables	111,937	157,053	198,121	353,372	571,401	1,066,081	1,800,076	4.96	2.35	6.31	2.21	2.32	2.04
28) Paper	92,747	212,979	357,546	377,456	735,750	1,244,375	1,862,767	6.70	4.40	4.56	6.90	5.40	4.12
15) Manufactured Fertilizers	75,851	106,325	128,030	221,240	324,616	467,161	686,702	4.94	1.88	5.62	3.91	3.71	3.93
29) Other Min. & Metal Manu.	73,601	118,861	157,636	214,293	410,274	786,107	1,455,507	7.09	2.86	3.12	6.71	6.72	6.35
36) Auto Parts/Motocycles	64,901	69,550	72,651	74,256	76,004	63,810	52,169	0.99	0.44	0.22	0.23	-1.73	-1.99
10) Rubber	62,133	113,616	183,309	199,565	200,299	211,886	230,393	9.00	0.90	0.85	0.04	0.56	0.84
32) Heavy Industrial Machinery	60,155	73,613	92,556	211,832	289,734	401,504	555,259	2.93	2.32	8.63	3.18	3.32	3.30
2) Meat, Fish & Dairy Products	49,763	98,935	153,715	200,562	223,917	227,801	234,204	10.32	4.50	2.70	1.11	0.17	0.28
11) Lumber & Wood	49,755	85,991	124,090	210,569	316,538	460,265	646,118	8.13	3.74	5.43	4.16	3.81	3.45
27) Textile, Leather & Rubber Mtls	39,271	77,756	159,931	245,071	258,381	284,436	329,198	10.25	7.48	4.36	0.53	0.97	1.47
28) Plastics & Chemical Prod.	35,200	77,756	121,474	165,101	207,018	270,453	349,311	10.51	5.54	3.12	2.29	2.71	2.59
38) Electrical Equipment	20,371	23,851	42,131	53,819	49,685	48,392	49,092	2.28	5.85	2.48	-0.80	-0.26	0.14
4) Grain	11,407	15,344	24,165	28,369	31,960	36,029	43,697	4.33	4.65	1.62	0.29	1.21	1.95
40) Commodities, NES	11,067	11,295	10,258	10,563	10,372	10,095	9,950	0.29	-0.96	0.29	-0.18	-0.27	-0.14
7) Textile Fibers, Hides	6,510	8,369	14,633	25,079	28,846	32,452	36,241	3.65	5.75	5.54	1.41	1.18	1.11
9) Oils & Fats	5,046	3,277	2,333	3,324	5,607	10,019	15,666	-5.98	-3.34	3.80	5.37	5.98	4.57
23) Liquid Bulk Chemicals	4,881	6,589	7,906	11,482	15,121	20,087	27,369	4.38	1.84	3.80	2.79	2.88	3.14
25) Pharmaceuticals	283	245	347	347	667	1,080	1,647	-2.04	-6.00	10.15	6.75	4.94	4.31
8) Oilseeds	271	478	799	1,317	1,618	1,973	2,531	8.44	5.27	5.12	2.08	2.00	2.52
37) Aircraft & Ships	0	0	0	0	0	0	0	0	0	0	0	0	0
22) Natural & Manufactured Gas	0	0	0	0	0	0	0	0	0	0	0	0	0
1) Live Animals	0	0	0	0	0	0	0	0	0	0	0	0	0
13) Phosphates	0	0	0	0	0	0	0	0	0	0	0	0	0
20) Crude Petroleum	11,261,570	16,039,722	21,438,172	33,625,943	42,141,013	59,085,607	82,431,105	5.18	2.94	4.60	2.28	3.44	3.39
TOTALS													

Source: DRUMer World Sea Trade Service, 95Q1 forecast

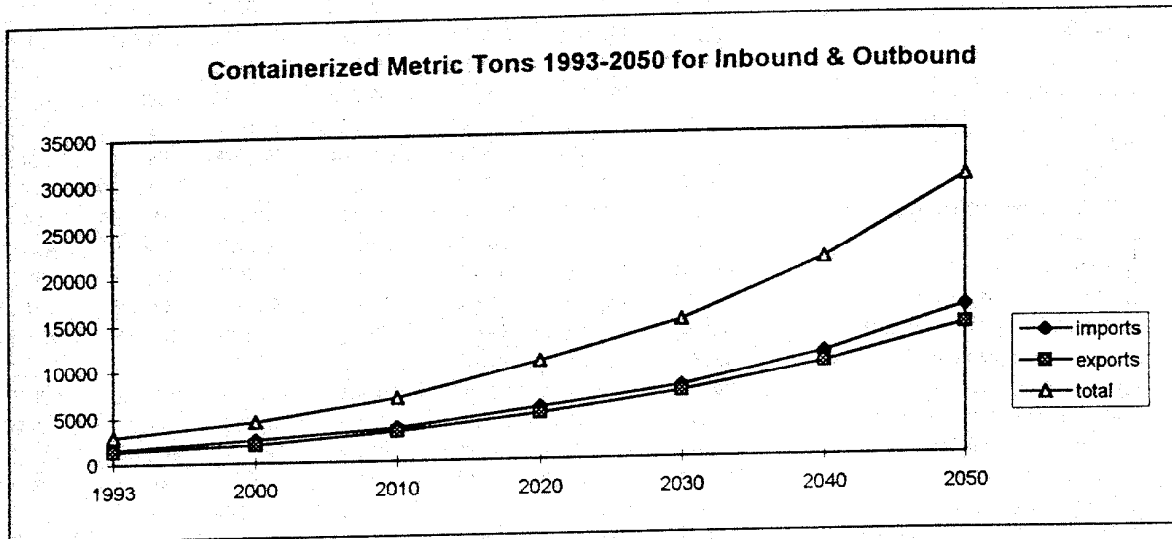
These four products will represent the bulk of inbound trade (60%), but they will not necessarily be the products showing the most growth (see Table 5).

Table 5, above, includes all inbound foreign commodities in 1993-2050. Growth rates for certain products are expected to be as high as 5.6 percent annually for the period from 1993 through 2010. Faster growing cargoes include major commodities such as petroleum products as imports of petroleum products for large consumer markets on the East Coast are increasingly required. Other growing inbound cargoes include: non-ferrous metals, heavy transportation equipment, light industrial machinery, paper, manufactured fertilizers, other mineral and metal manufacturers, auto parts/motorcycles, meat, fish & dairy products, and textile, leather goods.

An increase is also anticipated for consumer and industrial manufactured goods, reflecting the predicted economic recovery over this period and the likelihood of increased demand for commodities of this type. By 2010, these products are expected to become a more significant part of Baltimore's imports, increasing from 9 percent in 1993 to 10 percent in 2010, further climbing to 16% in 2040. Other imported commodities due to decline over time are coal & coke, passenger cars, rubber, and textile fibers and hides.

## Containerized Foreign Cargo Forecast

**CHART 6**  
**TOTAL FOREIGN CONTAINERIZED METRIC TONS FOR 1993 - 2050**  
(000s metric tons)



Previous discussions regarding trade for the Port of Baltimore have included all metric tonnage-containerized and noncontainerized. This section will describe the expected growth of metric tons moving in containers. From Chart 6 above, it is apparent that containerized trade is forecast to grow significantly through 2050. Containerized trade will be balanced for the most part, with import tonnage nearly the same as export tonnage.

### Outbound Containerized Commodities

Table 6 details the exported containerized commodities for the 1993-2050 timeframe. The first three commodities, lumber & wood, plastics & chemical products, and other chemicals, maintain a leading edge with steady growth. By 2050, the top four containerized commodities have been replaced in rank by the following commodities: other chemicals, consumer goods, light industrial machinery, and other mining and metal manufacturers.

**TABLE 6**  
**TOTAL BALTIMORE OUTBOUND CONTAINERIZED TONNAGE, 1993-2050**

<u>Commodity</u>	<u>1993</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>	<u>2040</u>	<u>2050</u>
(11) Lumber & Wood	171,616	244,249	352,761	495,251	573,842	656,392	719,854
(26) Plastics & Chemical Products	114,247	171,283	278,613	420,663	586,314	776,163	993,315
(24) Other Chemicals	104,834	152,444	239,980	436,382	771,738	1,326,721	2,046,921
(4) Grain	86,427	89,497	96,658	83,131	64,456	56,417	51,140
(39) Consumer Goods	85,289	129,982	226,828	427,238	715,633	1,083,385	1,611,150
(33) Light Industrial Machinery	83,976	105,180	171,329	311,721	548,023	859,690	1,293,358
(28) Paper	73,863	94,384	136,574	250,944	391,478	566,079	794,830
(8) Oilseeds	69,995	58,305	52,645	48,002	44,803	45,249	45,768
(29) Other Min & Metal Manufactures	68,063	114,047	223,987	339,982	500,854	759,160	1,114,190
(30) Iron & Steel	66,272	90,869	156,770	302,899	429,497	588,264	803,983
(6) Food Products	60,751	104,728	197,427	267,314	312,749	376,496	459,951
(31) Non-Ferrous Metals	47,373	48,835	51,882	122,444	204,262	329,916	544,077
(2) Meat, Fish & Dairy Products	45,566	91,249	179,451	307,135	427,548	575,350	791,230
(36) Auto Parts/Motorcycles	45,093	76,633	160,916	176,751	209,873	247,618	321,305
(38) Electrical Equipment	39,362	63,584	112,388	194,465	315,189	474,222	695,727
(32) Heavy Industrial Machinery	37,224	49,565	87,604	116,169	136,629	147,271	159,065
(12) Pulp & Waste Paper	30,916	40,352	68,962	90,369	76,557	105,886	163,730
(7) Textile Fibers; Hides	30,272	27,848	35,810	42,793	46,910	46,126	45,855
(40) Commodities, NES	23,434	22,511	21,146	42,280	73,038	97,862	135,577
(27) Textile, Leather & Rubber Mtls	23,045	32,378	46,533	74,201	102,453	127,577	163,161
(25) Pharmaceuticals	20,236	31,942	66,901	109,079	167,937	258,629	374,864
(35) Passenger Cars	17,679	40,077	107,889	141,439	211,774	292,244	371,849
(10) Rubber	15,529	21,069	30,994	34,096	48,078	51,362	57,487
(3) Fruits & Vegetables	12,645	19,672	29,085	45,501	67,585	93,345	125,908
(14) Cement, Lime & Stone	10,262	18,885	34,462	42,409	53,266	65,344	83,741
(18) Other Ores & Scrap	7,346	10,436	18,395	23,517	23,403	21,591	19,797
(5) Sugar	4,386	7,567	15,800	25,971	35,532	46,627	57,906
(23) Liquid Bulk Chemicals	3,792	4,565	6,463	9,931	13,475	19,655	29,371
(9) Oils & Fats	1,010	1,617	2,730	2,883	2,458	2,046	1,714
<b>TOTAL</b>	<b>1,400,503</b>	<b>1,963,753</b>	<b>3,210,986</b>	<b>4,984,960</b>	<b>7,155,356</b>	<b>10,096,690</b>	<b>14,076,820</b>

#### **Inbound Containerized Commodities**

Total tonnage for inbound containerized commodities in 1993 is 11 percent greater than that of containerized export tonnage for the same year (see Table 7). From 1993 to the year 2000, exports are approximately 77 percent of total containerized import tonnage. However, between 2000 and 2010, containerized exports take off, as inbound cargoes slow, resulting in exports at 88 percent of total inbound containerized metric tons. By 2030, containerized

exports are 92 percent of total containerized imports. By 2050, containerized import and export flows have resumed their 1993 relationship.

**TABLE 7**  
**TOTAL BALTIMORE INBOUND CONTAINERIZED TONNAGE, 1993-2050**

<u>Commodity</u>	1993	2000	2010	2020	2030	2040	2050
(30) Iron & Steel	190,678	309,734	352,861	434,118	424,234	434,654	464,998
(6) Food Products	156,793	202,979	237,930	383,610	555,546	845,679	1,311,131
(39) Consumer Goods	139,152	207,272	265,042	497,643	742,676	1,186,314	1,793,532
(12) Pulp & Waste Paper	129,400	260,471	538,671	610,609	484,850	597,163	711,222
(31) Non-Ferrous Metals	120,613	244,274	418,896	866,174	1,432,743	2,207,117	3,221,091
(5) Sugar	81,530	90,912	80,505	217,476	317,201	382,664	452,197
(28) Paper	80,547	127,365	195,646	302,975	580,560	966,503	1,432,996
(33) Light Industrial Machinery	78,350	116,612	138,897	204,430	354,737	632,114	1,046,041
(24) Other Chemicals	71,044	127,463	184,838	268,918	394,367	616,101	953,624
(29) Other Min & Metal Manufactures	64,797	91,331	110,508	192,234	282,701	407,854	601,197
(3) Fruits & Vegetables	58,900	85,929	106,524	198,367	246,478	306,624	367,417
(27) Textile, Leather & Rubber Mtls	47,027	81,405	117,585	200,049	301,287	438,651	616,038
(32) Heavy Industrial Machinery	46,328	84,716	136,489	148,805	148,970	156,901	169,901
(2) Meat, Fish & Dairy Products	40,797	41,818	40,201	93,539	138,477	200,119	286,595
(26) Plastics & Chemical Products	35,688	70,856	146,083	224,186	237,169	262,646	305,546
(14) Cement, Lime & Stone	34,659	56,038	70,584	166,840	285,228	436,792	631,288
(38) Electrical Equipment	33,963	68,602	117,554	160,238	201,869	264,136	341,437
(11) Lumber & Wood	32,549	65,357	102,166	133,626	149,440	152,528	157,525
(36) Auto Parts/Motorcycles	31,408	53,475	89,797	129,476	239,383	446,895	825,912
(35) Passenger Cars	24,119	35,818	42,261	27,124	15,086	9,700	7,151
(4) Grain	20,298	23,772	41,996	53,606	49,460	48,125	48,754
(10) Rubber	14,627	16,151	19,661	22,057	24,784	25,350	25,672
(7) Textile Fibers; Hides	10,692	10,956	9,922	10,239	10,081	9,834	9,715
(40) Commodities, NES	10,263	13,765	21,623	24,340	26,510	28,915	34,144
(18) Other Ores & Scrap	9,362	19,885	28,082	38,847	67,511	114,106	168,685
(25) Pharmaceuticals	4,539	6,075	7,237	10,560	13,981	18,660	25,549
(9) Oils & Fats	3,429	4,651	7,859	13,897	15,510	16,941	18,566
(23) Liquid Bulk Chemicals	2,188	1,718	1,270	1,595	2,136	3,039	4,089
(15) Manufactured Fertilizers	767	732	615	1,476	1,583	2,620	4,196
(8) Oilseeds	263	228	124	327	635	1,044	1,608
<b>TOTAL</b>	<b>1,574,771</b>	<b>2,520,358</b>	<b>3,631,425</b>	<b>5,637,380</b>	<b>7,745,192</b>	<b>11,219,790</b>	<b>16,037,820</b>

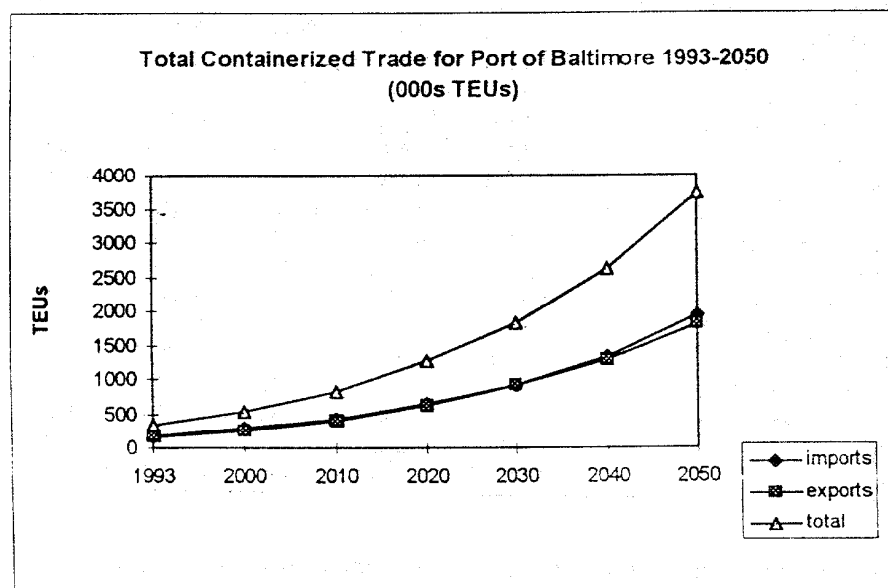
Over the time period, containerized exports move toward more finished products. In 1993, the largest tonnage groups are iron & steel, food products, consumer goods, pulp & waste paper, and non-ferrous metals, sugar and paper. By 2050, these larger moving commodities

are non-ferrous metals, consumer goods, paper, food products and light industrial machinery, other chemicals and auto parts/motorcycles.

### Containerized Cargo Forecast - TEUs

The containerized metric tonnage described above, can also be reviewed on a TEU (twenty foot equivalent unit) basis. In this way, the volume or number of TEUs or containers may be reviewed for each commodity traded. From Chart 7 below, the movement of containers through the Port of Baltimore is fairly balanced for the time period. For every inbound TEU there is an outbound TEU. It is important to note the steady rise in TEUs. By the year 2050, there are over 3.7 million TEUs moving through the port, compared with the current 336,000 TEUs. Tables 8 and 9 provide detail for outbound and inbound containerized activity.

CHART 7



**TABLE 8**  
**OUTBOUND CONTAINERIZED TRADE FOR THE PORT OF BALTIMORE FROM**  
**1993-2050 IN TEUs**

<u>Commodity</u>	<u>1993</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>	<u>2040</u>	<u>2050</u>
(11) Lumber & Wood	19,016	30,071	43,430	60,973	70,648	80,812	88,625
(39) Consumer Goods	17,956	27,365	47,753	89,945	150,660	228,081	339,189
(26) Plastics & Chemical Products	12,948	19,412	31,576	47,675	66,449	87,965	112,576
(33) Light Industrial Machinery	12,310	15,419	25,116	45,696	80,336	126,024	189,596
(4) Grain	9,573	11,014	11,895	10,230	7,932	6,943	6,293
(36) Auto Parts/Motorcycles	9,019	15,327	32,183	35,350	41,975	49,524	64,261
(24) Other Chemicals	8,828	14,264	22,454	40,831	72,209	124,138	191,525
(28) Paper	7,948	11,284	16,329	30,002	46,804	67,679	95,028
(38) Electrical Equipment	7,097	11,464	20,264	35,063	56,830	85,504	125,442
(6) Food Products	5,400	9,309	17,549	23,761	27,800	33,466	40,885
(29) Other Min & Metal Manufactures	5,159	9,604	18,863	28,631	42,179	63,932	93,830
(30) Iron & Steel	4,949	7,539	13,006	25,130	35,633	48,805	66,702
(8) Oilseeds	4,827	4,021	3,671	3,310	3,090	3,121	3,156
(40) Commodities, NES	4,687	4,502	4,229	8,456	14,608	19,572	27,115
(2) Meat, Fish & Dairy Products	4,658	9,328	18,344	31,396	43,705	58,814	80,881
(32) Heavy Industrial Machinery	3,758	5,004	8,845	11,729	13,794	14,869	16,059
(31) Non-Ferrous Metals	3,755	4,301	4,569	10,783	17,988	29,053	47,913
(35) Passenger Cars	3,501	7,936	21,364	28,008	41,935	57,870	73,633
(27) Textile, Leather & Rubber Mtls	3,139	4,410	6,339	10,108	13,956	17,378	22,225
(25) Pharmaceuticals	3,120	4,924	10,314	16,816	25,890	39,872	57,792
(12) Pulp & Waste Paper	3,077	4,462	7,625	9,992	8,465	11,708	18,104
(7) Textile Fibers; Hides	2,624	2,414	3,104	3,710	4,066	3,999	3,975
(3) Fruits & Vegetables	1,371	2,133	3,153	4,932	7,326	10,119	13,649
(10) Rubber	1,202	1,631	2,399	2,639	3,721	3,975	4,449
(14) Cement, Lime & Stone	885	1,629	2,973	3,659	4,595	5,638	7,225
(18) Other Ores & Scrap	508	721	1,271	1,625	1,618	1,492	1,368
(23) Liquid Bulk Chemicals	337	406	574	883	1,198	1,747	2,611
(5) Sugar	331	572	1,194	1,962	2,685	3,523	4,375
(9) Oils & Fats	101	162	273	288	246	205	171
<b>TOTAL</b>	<b>162,082</b>	<b>240,627</b>	<b>400,620</b>	<b>623,584</b>	<b>908,342</b>	<b>1,285,826</b>	<b>1,798,656</b>

**TABLE 9**  
**INBOUND CONTAINERIZED TRADE FOR THE PORT OF BALTIMORE FROM**  
**1993-2050 IN TEUs**

<b>Commodity</b>	<b>1993</b>	<b>2000</b>	<b>2010</b>	<b>2020</b>	<b>2030</b>	<b>2040</b>	<b>2050</b>
(39) Consumer Goods	29,295	43,636	55,798	104,767	156,353	249,750	377,586
(30) Iron & Steel	14,237	25,697	29,275	36,016	35,196	36,061	38,578
(6) Food Products	13,937	18,043	21,149	34,099	49,382	75,171	116,545
(12) Pulp & Waste Paper	12,877	28,800	59,561	67,515	53,610	66,029	78,640
(33) Light Industrial Machinery	11,266	16,773	19,995	29,326	50,720	90,113	148,899
(31) Non-Ferrous Metals	9,535	21,468	36,832	76,150	125,929	193,975	283,079
(28) Paper	8,667	15,228	23,391	36,223	69,411	115,553	171,326
(3) Fruits & Vegetables	6,529	9,499	11,785	21,926	27,175	33,754	40,392
(27) Textile, Leather & Rubber Mtls	6,406	11,089	16,017	27,250	41,041	59,752	83,915
(36) Auto Parts/Motorcycles	6,282	10,695	17,959	25,895	47,877	89,379	165,182
(5) Sugar	6,160	6,869	6,083	16,432	23,966	28,912	34,166
(38) Electrical Equipment	6,124	12,369	21,195	28,891	36,398	47,624	61,562
(24) Other Chemicals	5,983	11,926	17,295	25,162	36,900	57,647	89,228
(29) Other Min & Metal Manufactures	4,911	7,691	9,306	16,189	23,807	34,347	50,629
(35) Passenger Cars	4,776	7,093	8,368	5,371	2,987	1,921	1,416
(32) Heavy Industrial Machinery	4,677	8,553	13,780	15,024	15,040	15,841	17,154
(2) Meat, Fish & Dairy Products	4,192	4,312	4,172	9,704	14,339	20,704	29,631
(26) Plastics & Chemical Products	4,045	8,030	16,556	25,408	26,879	29,767	34,628
(11) Lumber & Wood	3,606	8,046	12,578	16,451	18,398	18,778	19,394
(14) Cement, Lime & Stone	2,990	4,835	6,090	14,394	24,608	37,684	54,464
(4) Grain	2,248	2,925	5,168	6,597	6,087	5,922	6,000
(40) Commodities, NES	2,053	2,753	4,325	4,868	5,302	5,783	6,829
(10) Rubber	1,163	1,285	1,557	1,742	1,952	1,987	2,004
(7) Textile Fibers; Hides	927	950	860	888	874	853	842
(25) Pharmaceuticals	700	937	1,116	1,628	2,155	2,877	3,939
(18) Other Ores & Scrap	647	1,374	1,941	2,685	4,666	7,887	11,659
(9) Oils & Fats	343	465	786	1,390	1,551	1,694	1,857
(23) Liquid Bulk Chemicals	194	153	113	142	190	270	363
(15) Manufactured Fertilizers	51	49	41	98	106	175	280
(8) Oilseeds	18	16	9	23	44	72	111
<b>TOTAL</b>	<b>174,840</b>	<b>291,558</b>	<b>423,101</b>	<b>652,252</b>	<b>902,942</b>	<b>1,330,283</b>	<b>1,930,298</b>

### Trade Route Forecast

In the existing conditions report, the global trade route systems were introduced and discussed. In this section, forecasted changes or shifts in trade will be introduced. This will be followed by a more detailed analysis for the Port of Baltimore. These trade routes to be discussed are exclusive of crude petroleum. The impact of global trade developments and the vessels and vessel types serving global trades will impact the vessels and vessel types calling at

the Port of Baltimore. However, due to the significant volumes of crude petroleum in global trade, the major global trade routes tend to be dominated by the crude flows and the tankers that carry the crude. Therefore, in order to focus on the vessels and vessel types serving more diverse trades, the global analysis focused on trade routes excluding crude petroleum. While the levels of crude included in Baltimore's trade flows are relatively small and would not limit the diversity of cargo and vessels in the trade, for consistency with the global analysis of commodity flows and vessel types on key routes, the crude petroleum flows were excluded from this analysis.

**TABLE 10  
TEN LARGEST GLOBAL TRADE ROUTES FOR 2000 AND 2050  
(EXCLUDES CRUDE PETROLEUM)**

<u>Globe Year 2000</u>	<u>Metric Tons</u>	<u>Globe Year 2050</u>	<u>Metric Tons</u>
Australia/New Zealand to Japan	185,537,792	SE Asia to Far East NIC's	2,012,670,080
Australia/New Zealand to Far East NIC's	107,276,408	Australia/New Zealand to Far East NIC's	1,340,825,472
SE Asia to Far East NIC's	89,803,856	Arabian Gulf to FE NIC's	1,237,114,368
SE Asia to Japan	88,892,664	China to Far East NIC's	933,136,192
China to Far East NIC's	85,340,376	South America EC to FE NIC's	915,116,224
South America EC to Northern Europe	60,516,588	Far East NIC's to South East Asia	800,354,624
Japan to Far East NIC's	49,577,360	Far East NIC's to China	791,052,480
China to Japan	44,736,920	Australia/New Zealand to China	751,717,120
Australia/New Zealand to Northern Europe	43,252,044	Southern Europe to other Med	438,107,840
South America EC to Japan	41,105,120	Other Med to Northern Europe	437,500,512

Table 10 indicates the changes in the largest global trades for years 2000 and 2050. The largest global trade lanes do not include the United States. However, these trade lane projections indicate the importance and strength of trade among other trading nations, especially those in proximity to the Pacific Ocean. The Far East Newly Industrialized Countries (NIC's) become prominent trading partners during this time period, as well as South East Asia and Australia/New Zealand.

**TABLE 11**

**TEN LARGEST UNITED STATES' TRADE ROUTES FOR 2000 AND 2050**  
**(EXCLUDES CRUDE PETROLEUM)**

<u>U.S. Year 2000</u>	<u>Metric Tons</u>	<u>U.S. Year 2050</u>	<u>Metric Tons</u>
U.S. Southwest Coast to Japan	30,848,078	Caribbean Basin to U.S. Gulf Coast	249,998,560
Caribbean Basin to U.S. Gulf Coast	28,125,820	Arabian Gulf to U.S. Gulf Coast	225,991,392
U.S. Gulf Coast to Japan	25,761,348	South America EC to U.S. Northeast Coast	192,734,272
South America EC to U.S. Northeast Coast	24,029,980	Caribbean Basin to U.S. Southeast Coast	182,721,344
U.S. Gulf Coast to Northern Europe	22,576,104	U.S. Northwest Coast to Far East NIC's	173,931,760
U.S. Northeast Coast to Northern Europe	21,868,590	U.S. Gulf Coast to Far East NIC's	153,035,296
Other Med to U.S. Gulf Coast	20,521,084	Caribbean Basin to U.S. Northeast Coast	151,214,160
U.S. Gulf Coast to Caribbean Basin	20,404,690	China to U.S. Northwest Coast	125,592,712
Northern Europe to U.S. Northeast Coast	19,438,216	South America EC to U.S. Southeast Coast	115,693,576
U.S. Gulf Coast to Other Med	18,814,962	Arabian Gulf to U.S. Northeast Coast	105,810,792

Table 11 details the top trade lanes on a total metric ton basis. In addition, it provides a view of the forecasted changes in trade. In the year 2000, the majority of the top trade lanes utilize the Gulf coast, followed by the Northeast Coast. However, by 2050, trade has diversified to include activity at all coastal regions. Trade relationships with Northern Europe, Japan, and the Caribbean Basin are relevant in 2000. However, these relationships appear to change, so that by the year 2050, the relative significance of trade with Japan and Northern Europe has declined. Large trading partners by 2050 are the Caribbean Basin and the Far East NIC's. As stated previously, the trade routes shown in Table 11 do not include the major crude petroleum trade routes. The 226 million metric tons forecast to flow from the Arabian Gulf to the US Gulf Coast and the 105 million metric tons from the Arabian Gulf to the US East Coast are petroleum products and not crude petroleum. Many of the oil producing countries in the Middle East are now constructing and operating refining operations. Instead of exporting only crude petroleum, they are increasingly exporting refined petroleum products.

Growth in the import of petroleum products is due to constraints on refining facilities in the NorthEast United States. Due to relatively outdated existing refining facilities and the environmental requisites associated with upgrade and construction of new facilities,

constrained growth is represented in the forecast. Within the NorthEast United States, a shift is occurring away from crude petroleum refining and toward the import of refined petroleum products.

**TABLE 12**  
**TEN LARGEST U.S. NORTH ATLANTIC STATES TRADE ROUTES FOR 2000 AND 2050**  
**(EXCLUDES CRUDE PETROLEUM)**

<u>North Atlantic Year 2000</u>	<u>Metric Tons</u>	<u>North Atlantic Year 2050</u>	<u>Metric Tons</u>
South America EC to U.S. Northeast Coast	24,029,980	South America EC to U.S. Northeast Coast	192,734,272
U.S. Northeast Coast to Northern Europe	21,868,590	Caribbean Basin to U.S. Northeast Coast	151,214,160
Northern Europe to U.S. Northeast Coast	19,438,216	Arabian Gulf to U.S. Northeast Coast	105,810,792
U.S. Northeast Coast to Southern Europe	13,827,891	Northern Europe to U.S. Northeast Coast	73,926,344
Caribbean Basin to U.S. Northeast Coast	10,871,582	South America WC to U.S. Northeast Coast	52,701,756
Southern Europe to U.S. Northeast Coast	9,255,135	Southern Europe to U.S. Northeast Coast	41,445,360
U.S. Northeast Coast to Far East NIC's	7,889,427	U.S. Northeast Coast to South America EC	39,940,168
South America WC to U.S. Northeast Coast	6,677,117	U.S. Northeast Coast to Far East NIC's	34,680,872
U.S. Northeast Coast to South America EC	6,466,713	SE Asia to U.S. Northeast Coast	32,089,802
U.S. Northeast Coast to Japan	5,415,466	China to U.S. Northeast Coast	28,357,340

Table 12 presents the top ten trade lanes for the North Atlantic trade. The forecasted trade for year 2000 and 2050 indicates that South America will become the largest trading partner for the North Atlantic region. However, Northern Europe and the Caribbean Basin will continue to be important trading partners. Also, by the year 2050, the Arabian Gulf, Southeast Asia and China will become significant trading partners, as well.

**TABLE 13**  
**TEN LARGEST U.S. SOUTH ATLANTIC STATES' TRADE ROUTES FOR 2000 AND 2050**  
**(EXCLUDES CRUDE PETROLEUM)**

<u>South Atlantic Year 2000</u>	<u>Metric Tons</u>	<u>South Atlantic Year 2050</u>	<u>Metric Tons</u>
South America EC to U.S. Southeast Coast	14,293,927	Caribbean Basin to U.S. Southeast Coast	182,721,344
Caribbean Basin to U.S. Southeast Coast	11,915,591	South America EC to U.S. Southeast Coast	115,693,576
South America WC to U.S. Southeast Coast	5,962,898	U.S. Southeast Coast to South America EC	71,631,400
U.S. Southeast Coast to Northern Europe	5,421,460	South America WC to U.S. Southeast Coast	38,859,472
Northern Europe to U.S. Southeast Coast	5,020,645	U.S. Southeast Coast to Far East NIC's	28,715,644
U.S. Southeast Coast to Caribbean Basin	4,666,924	U.S. Southeast Coast to Caribbean Basin	27,382,032
U.S. Southeast Coast to South America EC	3,647,579	Southern Europe to U.S. Southeast Coast	24,462,808
Southern Europe to U.S. Southeast Coast	3,557,979	U.S. Southeast Coast to Northern Europe	18,101,106
U.S. Southeast Coast to Far East NIC	2,998,652	U.S. Southeast Coast to SE Asia	17,580,706
U.S. Southeast Coast to Japan	2,870,376	Indian Subcontinent to U.S. Southeast Coast	15,544,088

Table 13 exhibits the top ten trade routes for the South Atlantic region of the United States. The Table for the year 2000 indicates the importance of the South American trade, as the number one trade lane based on total metric tons. This trade continues to be an important part of the South Atlantic region's trade, as it becomes the second largest lane in 2050. The Caribbean Basin is also important to the South Atlantic ports. Northern and Southern Europe remain important trading partners, as well. In 2050, the Indian Sub-Continent becomes an active trading partner in the top ten, as Japan is removed from the list.

**TABLE 14**  
**TEN LARGEST BALTIMORE TRADE ROUTES FOR 2000 AND 2050**  
**(EXCLUDES CRUDE PETROLEUM)**

<u>Baltimore Year 2000</u>	<u>Metric Tons</u>	<u>Baltimore Year 2050</u>	<u>Metric Tons</u>
POB to Northern Europe	3,610,443	South America EC to POB	21,039,706
South America EC to POB	3,100,703	Caribbean Basin to POB	14,778,280
POB to Other Med	2,057,362	POB to South America EC	8,944,902
POB to Eastern Europe	1,968,306	POB to Eastern Europe	7,851,774
POB to Southern Europe	1,895,802	POB to Other Med	5,010,291
Northern Europe to POB	1,425,128	Northern Europe to POB	4,657,715
POB to Japan	1,364,443	POB to Northern Europe	4,345,646
Caribbean Basin to POB	1,359,816	Australia/New Zealand to POB	4,334,074
Australia/New Zealand to POB	1,160,371	POB to Southern Europe	1,733,204
POB to South America EC	1,130,708	POB to Japan	832,256

The Port of Baltimore's prominent trading partners remain the same over the time period 1993-2050 (see Table 14). However, by 2050, South American imports are the largest trade lane, followed by the Caribbean Basin. To further study this activity, refer to Table 15 below. The trade lanes shown in Table 14 are directional trade lanes, that is the table ranks the trade volumes separately for each direction of trade. For instance, by the year 2050 the largest trade lane is inbound to the Port of Baltimore from the East Coast of South America, while it was the second largest trade lane in the year 2000. Significantly, the projected traffic for the outbound direction in this trade lane from the Port of Baltimore to the East Coast of South America ranked third in Table 14 for the year 2050, up from tenth place in the year 2000.

**TABLE 15**  
**PORT OF BALTIMORE'S LARGEST TRADING PARTNERS FOR YEAR 2000 IN METRIC TONS FOR ALL CARGOES**

Commodity	Port of Baltimore to Europe	Port of Baltimore to South America East Coast to Port of Baltimore	Port of Baltimore to Other Med.	Port of Baltimore to E. Europe	Port of Baltimore to Europe	Port of Baltimore to S. Europe	Port of Baltimore to Japan	Port of Baltimore to Caribbean Basin to Port of Baltimore	Australia/New Zealand to Port of Baltimore	Port of Baltimore to South America, E. Coast
1) Live Animals	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2) Meat, Fish & Dairy Products	6,843	20,454	861	50,355	3,524	4,489	1,280	66	82	1,465
3) Fruits & Vegetables	2,410	3,555	1,455	1,173	783	6,089	39	291	NA	4,013
4) Grain	58,891	178	684,642	57,767	146,535	58	91,577	235,989	8,052	1,808
5) Sugar	122	173,492	1,535	219	NA	207	10	384	44	2,682
6) Food Products	38,272	34,225	6,530	24,631	1,428	91,461	73	NA	41	9,611
7) Textile Fibers	18,207	641	32	116	541	1,034	563	NA	NA	1,684
8) Hides	39,725	35	49,294	41,666	418,383	152	249,851	NA	NA	250
9) Oilseeds	353	504	87	97	NA	142	NA	NA	NA	235
10) Oils & Fats	15,487	332	54	8	376	3,829	NA	NA	NA	4,906
11) Rubber	221,491	5,395	4,304	857	51,174	28,463	5,865	184	475	2,504
12) Lumber & Wood	10,590	583,536	318	NA	4,539	176	199	NA	NA	3,010
13) Pulp & Waste Paper	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14) Phosphates	6,397	421,830	271	4,655	7	1,2091	NA	847,261	979	8,356
15) Cement, Lime & Stone	NA	134	NA	NA	NA	25,850	NA	NA	NA	0
16) Manufactured Fertilizers	NA	687,527	NA	NA	NA	NA	NA	NA	560,393	NA
17) Iron Ore	10,366	22,500	5	NA	NA	1,704	NA	NA	311,686	43
18) Bauxite & Oth. Base Metal Ores	1,554	86,624	NA	NA	337	10,665	202	145	NA	652
19) Other Ores & Scrap	2,499,917	NA	1,264,413	1,731,052	1,189,822	NA	974,658	NA	269,538	787,039
20) Coal & Coke	18	NA	NA	NA	180	92,092	24	241,278	NA	5,567
21) Crude Petroleum	16,177	527,437	9,353	4,221	NA	0	NA	NA	NA	NA
22) Petroleum Products	8	NA	3	NA	6	1,007	NA	NA	NA	467
23) Natural & Manuf. Gas	5,423	1,816	18	38	3,069	81,101	130	32,001	1,465	43,952
24) Liquid Bulk Chemicals	52,945	39,343	941	2,112	593	4,080	7	NA	NA	6,225
25) Other Chemicals	14,691	761	1,752	2,261	8,308	34,077	300	56	90	41,989
26) Pharmaceuticals	70,370	9,507	733	868	1,314	15,944	495	NA	400	2,770
27) Plastics & Chemical Products	17,438	16,337	902	1,260	588	60,570	NA	NA	100	15,293
28) Textile, Leather & Rubber Mtls	49,628	77,730	2,089	567	4,689	24,072	77	108	NA	35,703
29) Paper	25,129	13,082	3,062	379	7,675	264,779	76	NA	NA	34,589
30) Other Min. & Metal Manuf	20,399	102,744	417	233	2,464	50,433	116	NA	4,535	2,579
31) Iron & Steel	16,436	52,939	6,327	4,208	1,728	58,624	50	NA	NA	15,295
32) Non-Ferrous Metals	15,791	20,741	4,776	1,072	2,587	42,516	10	NA	55	23,493
33) Heavy Industrial Machinery	37,468	93,781	2,708	2,681	4,935	227,068	45	NA	NA	19,254
34) Light Industrial Machinery	52,567	9,724	3,033	3,076	26,761	101,568	38,048	2	2,341	6,830
35) Heavy Trans. Equipment	150,308	10	916	307	1,448	6,704	160	NA	NA	3,132
36) Passenger Cars	55,558	70,938	131	2	1,286	400	NA	NA	NA	190
37) Auto Parts/Motorcycles	3,811	14	2,884	612	3,113	12,147	277	NA	17	20,959
38) Aircraft & Ships	12,650	4,024	2,207	4,306	7,266	33,686	294	1,496	63	23,339
39) Electrical Equipment	61,043	16,972	715	22,953	604	7,851	18	555	16	826
40) Consumer Goods	1,965	1,839	2,057,361	1,968,307	1,895,804	1,425,129	1,364,444	1,359,816	1,160,372	1,130,710
Totals	3,610,448	3,100,701	2,057,361	1,968,307	1,895,804	1,425,129	1,364,444	1,359,816	1,160,372	1,130,710

In the year 2000, the POB's largest export partner is Northern Europe at 3.6 million metric tons, with South America as the largest import partner with over 3 million metric tons. POB's largest export to Northern Europe continues to be coal & coke, making up over 70 percent of total metric tons transported. South American (East Coast) cargoes include iron ore, petroleum products, pulp & waste paper, sugar and iron & steel. POB's exports to the Mediterranean are largely coal & coke and grain. The port's exports to Eastern Europe parallel the Mediterranean's with 90 percent of total metric tons in coal & coke and 5 percent as grain and meat, fish & dairy products.

Referring to Table 15, the Port of Baltimore's export trade to Southern Europe is mostly coal & coke (63%) and oilseeds and grain. Imports from Northern Europe at year 2000, are characterized by iron & steel, heavy transportation equipment, cement, lime & stone, and passenger cars. POB's exports to Japan are nearly all coal & coke (71%) and oilseeds that are 18 percent of total metric tons. Caribbean Basin imports into the port are cement, lime and stone making up 62 percent of total tons carried. Also, sugar (17%) and petroleum products (18%) make up another 35 percent of total tonnage. Australia/New Zealand brings iron ore, bauxite, and coal & coke to the port in Year 2000. The port's exports to South America's East Coast have developed to support a more industrial partner. The POB's majority (82%) of outbound tonnage includes coal & coke, other chemicals, plastics & chemical products, and iron & steel.

**TABLE 16**  
**PORT OF BALTIMORE'S LARGEST TRADING PARTNERS FOR YEAR 2050 IN METRIC TONS FOR ALL CARGOES**

Commodity	South America East Coast to Port of Baltimore	Caribbean Basin to Port of Baltimore	Port of Baltimore to South America, E. Coast	Port of Baltimore to Europe	Port of Baltimore to E. Coast	Port of Baltimore to Other Med	Port of Baltimore to N. Europe	Port of Baltimore to N. Europe	Port of Baltimore to Australia/New Zealand to Port of Baltimore	Port of Baltimore to S. Europe	Port of Baltimore to Japan
1) Live Animals	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2) Meat, Fish & Dairy Products	76,536	565	22,548	225,207	4,824	23,261	32,664	1,274	15,556	7,052	NA
3) Fruits & Vegetables	22,528	2,405	86,950	3,247	5,076	31,291	7,077	NA	3,057	147	NA
4) Grain	164	NA	1,197	11,857	688,490	105	19,614	NA	55,533	58,288	NA
5) Sugar	817,783	1,344,270	41,518	333	7,500	455	549	7,387	NA	13	NA
6) Food Products	216,712	506	253,885	64,935	19,420	333,794	89,013	537	4,162	188	NA
7) Textile Fibers	759	NA	5,409	208	30	862	10,282	19	280	432	NA
8) Hides	143	NA	1,802	2,415	3,660	335	23,272	NA	317,768	241,029	NA
9) Oils & Fats	686	NA	663	59	95	107	675	NA	NA	NA	NA
10) Rubber	942	NA	25,445	12	64	8,413	33,498	NA	712	NA	NA
11) Lumber & Wood	16,317	531	14,993	1,308	6,691	27,722	543,636	4,049	116,570	7,338	NA
12) Pulp & Waste Paper	1,594,548	NA	9,249	2,341	NA	31	40,380	NA	27,492	294	NA
13) Phosphates	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14) Cement, Lime & Stone	5,250,196	9,108,347	161,348	46,623	585	294,921	16,104	1,012	13	NA	NA
15) Manufactured Fertilizers	79	NA	0	NA	NA	177,981	NA	NA	NA	NA	NA
16) Iron Ore	2,386,674	NA	NA	NA	NA	NA	NA	2,732,024	NA	NA	NA
17) Bauxite & Oth. Base Metal Ores	5,960	NA	626	NA	1	6,775	19,479	1,530,201	NA	NA	NA
18) Other Ores & Scrap	494,795	52	831	NA	NA	46,137	304	NA	937	156	NA
19) Coal & Coke	NA	NA	1,651,999	7,128,844	3,561,908	NA	418,213	10,611	752,872	452,241	NA
20) Crude Petroleum	5,097,973	4,217,306	81,399	24,497	256,627	300,688	155,711	NA	NA	NA	NA
21) Petroleum Products	NA	NA	NA	NA	642	0	618	NA	NA	72	NA
22) Natural & Manuf. Gas	12,468	NA	8,334	6	97	881	30,226	NA	NA	NA	NA
23) Liquid Bulk Chemicals	148,131	51,182	1,725,971	669	3,062	171,232	133,189	27,477	17,741	200	NA
24) Other Chemicals	4,524	NA	207,229	39,040	2,277	11,206	118,989	NA	2,031	22	NA
25) Pharmaceuticals	19,991	292	709,904	4,488	3,755	65,774	144,136	197	28,243	296	NA
26) Plastics & Chemical Products	194,524	NA	64,357	1,527	7,922	61,258	37,528	9,085	3,792	718	NA
27) Textile, Leather & Rubber Mtlis	1,434,023	NA	516,079	13,797	6,049	362,320	172,273	NA	1,916	NA	NA
28) Paper	96,287	1,830	968,573	1,234	2,306	51,982	66,756	1,196	19,323	107	NA
29) Other Min & Metal Manuf	75,805	NA	456,811	1,684	69,154	128,636	215,749	NA	27,832	36	NA
30) Iron & Steel	679,954	NA	17,580	27	480	61,825	44,113	4,368	12,301	88	NA
31) Non-Ferrous Metals	61,779	NA	59,032	74,769	23,701	94,505	9,319	NA	2,451	48	NA
32) Heavy Industrial Machinery	1,297,077	NA	576,773	21,359	95,160	96,300	332,469	570	50,267	81	NA
33) Light Industrial Machinery	184,733	NA	343,585	17,690	15,745	2,127,870	106,912	NA	20,771	327	NA
34) Heavy Trans. Equipment	11	4	46,657	2,538	114,709	11,543	897,149	2,998	141,197	57,862	NA
35) Passenger Cars	689,117	NA	40,477	461	21,043	14,560	209,044	NA	11,509	1,130	NA
36) Auto Parts/Motorcycles	31	NA	942	2	1,204	1,823	4,997	NA	15,033	NA	NA
37) Aircraft & Ships	14,812	NA	317,559	4,757	27,797	20,594	74,127	203	23,600	1,402	NA
38) Electrical Equipment	126,675	48,031	519,554	31,185	49,006	118,052	330,801	801	58,123	2,627	NA
39) Consumer Goods	18,569	2,981	632	124,997	8,873	4,477	8,776	66	1,497	2,081	NA
40) Commodities, NES	21,039,706	14,778,302	8,944,911	7,851,775	5,010,294	4,657,716	4,347,642	4,334,075	1,733,206	834,255	NA
Totals											

As shown in Table 16, South America remains the largest import partner at Baltimore, and is also the largest trading partner for the port (21 million metric tons). The commodity mix in this trade lane now includes: cement, lime & stone, petroleum products, iron ore, pulp & waste paper, paper, and light industrial machinery. Imports from the Caribbean are largely cement, lime & stone and petroleum products. These two commodities total 13 million metric tons, about 93 percent of total Caribbean metric tonnage carried to Baltimore. Port of Baltimore's exports to the South American East Coast are dominated by other chemicals (19%) -- which have grown considerably since Year 2000. POB's larger export tonnage also includes coal & coke (18%). Additional prominent commodities include other mining and metal manufacturers, plastics & chemical products, light industrial machinery, and consumer goods- these totaling 31 percent of total tonnage exported. The port's main export to Eastern Europe is coal & coke, which makes up 91 percent of total metric tons carried in this trade. Exports to the Mediterranean are still largely coal & coke (70%). Grain shipments make up 13 percent and petroleum products 5 percent of total export tons. POB's imports from Northern Europe include heavy transportation equipment (46%), food products (7%), paper (7%), cement, lime & stone (6%), and petroleum products (6%). Port of Baltimore's greatest export to Northern Europe is passenger cars, which make up 20 percent of total metric tons. The port's other large exports are lumber and coal & coke which make up 12 percent and 9 percent of total tonnage. Light industrial machinery, consumer goods, and iron & steel make up nearly 8 percent, 7 percent and 5 percent, respectively, of total tonnage. Australia/New Zealand imports are largely iron ore (62%) and bauxite (35%). The port's export to Southern Europe and Japan are quite similar. The two top commodities in each export trade lane are coal & coke and oilseeds.

#### **Vessel Forecasts Based on Metric Tons**

Below in Tables 17 and 18, forecasts of vessel type are presented. In Table 17, vessels are listed for the year 2000. Overall for the top ten trade lanes, bulk carriers will continue to

carry a large part of the tonnage. The Northern Europe to Baltimore trade involves a large part of metric tons in passenger cars and heavy transportation equipment. Due to this commodity mix, this trade lane utilizes vehicle carriers (21%) and Roll-on Roll-off vessels (16%) to transport nearly 37 percent of total tons. Container vessels carry another 30 percent of total tonnage. In the next fifty years, trade profiles will change resulting in different commodity mixes and different vessel types in the trade lanes.

TABLE 17		Port of
PORT OF BALTIMORE'S LARGEST TRADING PARTNERS FOR YEAR 2000 IN METRIC TONS AND SHIPTYPES		Part of

PORT OF BALTIMORE'S LARGEST TRADING PARTNERS FOR YEAR 2000 IN METRIC TONS AND DWT										
Baltimore Vessels	Shiptype	South America		Port of Baltimore to E. Europe	Port of Baltimore to S. Europe	N. Europe to Port of Baltimore	Port of Baltimore to Japan	Caribbean Basin to Port of Baltimore	Australia/New Zealand to Port of Baltimore	Port of Baltimore to South America, E. Coast
		Port of East Coast to Baltimore	Port of Baltimore to Other Med.							
Gen Cargo >10,000	AA	211,953	627,879	134,642	390,395	282,100	169,432	23,027	91,073	107,429
AB	AB	4,898	11,788	0	0	43	48,420	203	0	9
Gen Cargo <10,000	AI	53,603	152,073	632	0	27	54,262	130	5,383	15,892
Cellular <1000 TEU	A2	147,551	331,315	71,384	3,191	73,538	146,719	91,610	29,709	187,729
Cellular 1000-2499 TEU	A3	219,267	128,310	17,726	3,622	37,729	138,566	178,089	7,530	49,581
Cellular 2500-3999 TEU	A4	144,917	81,568	3,412	4,194	11,202	84,517	85,492	1,638	13,219
Cellular 4000-5999 TEU	A5	0	0	0	0	0	0	0	0	0
Cellular 6000-7999 TEU	A6	0	0	0	0	0	0	0	0	0
Cellular >8000 TEU	AE	235,820	45,263	2,024	126,998	36,976	234,039	11,637	0	24,346
RoRo >10,000	AF	0	0	1,245	23	16,819	138	0	0	0
RoRo <10,000	BA	82	1,841	0	0	0	364	0	273	3
Reefer	DA	704	0	0	937	7,460	37	0	0	0
Bulk <20,000 DWT	DB	132,133	203,872	801,759	28,556	138,274	15,051	0	664,035	0
Bulk 20K to 40K DWT	DC	755,716	268,896	602,186	900,470	648,320	38,462	98,999	341,854	506,160
Bulk 40K to 80K DWT	DD	157,196	93,323	126,984	350,505	245,508	4,499	19,802	30,858	60,080
Bulk 80K to 100K DWT	DE	903,319	266,487	234,352	142,539	261,418	955	671,364	5,856	12,820
Bulk 100K to 175K DWT	DF	239,854	67,158	56,790	15,200	55,262	61	184,086	349	819
Bulk >175,000 DWT	EA	0	0	0	0	0	0	0	0	0
Combo <20,000 DWT	EB	0	0	0	0	0	0	0	0	0
Combo 20K to 40K DWT	EC	47,505	0	0	0	0	0	0	0	0
Combo 40K to 80K DWT	ED	11,754	0	0	0	7,464	0	0	0	0
Combo 80K to 100K DWT	EE	139,826	0	0	0	57,820	0	0	0	0
Combo 100K to 175K DWT	EF	38,313	0	0	0	15,657	0	0	0	0
Combo 175,000 DWT	FA	0	0	0	0	0	0	0	0	0
Tanker <16,500 DWT	FB	0	0	0	0	0	4,407	0	0	0
Tanker 16.5K to 25K DWT	FC	0	0	3,299	0	71	9,008	0	120,046	0
Tanker 25K to 45K DWT	FD	6,339	0	816	0	17	8,226	0	52,720	0
Tanker >45K to 80K DWT	FE	1,568	0	88	0	2	31,694	0	8,910	0
Tanker 80K to 160K DWT	FF	170	0	5	0	0	7,589	0	815	0
Tanker 160K to 250K DWT	FG	11	0	0	0	0	865	0	48	0
Tanker >250,000 DWT	PA	0	0	0	0	0	0	0	0	0
Prod. Tanker <16,500 DWT	PB	648	9,620	14	1,313	16	14,917	6	23,018	0
Prod. Tanker 16.5K to 25K DWT	PC	5,703	209,068	3	325	61	13,192	2	28,713	0
Prod. Tanker 25K to 45K DWT	PD	1,389	154,741	0	35	15	2,750	0	6,312	0
Prod. Tanker 45K to 80K DWT	PE	159	155,734	0	2	2	297	0	696	0
Prod. Tanker 80K to 160K DWT	GA	4,237	0	0	0	0	0	0	0	0
Gas Tankers	HB	145,813	0	0	0	0	304,938	0	0	0
Vehicle Carriers	XX	0	291,765	0	2	3	91,724	1	560,393	10
Other Ships		3,610,448	3,100,701	2,057,361	1,968,307	1,895,804	1,425,129	1,364,444	1,359,816	1,130,710
TOTALS										

Table 18 lists Baltimore's vessel activity for year 2050. In this analysis, the vessels that carry the majority of tonnage are containers, vehicle carriers, and bulk carriers. Although the bulk carriers are involved in a large part of tonnage moves, they are not utilized to the same extent in 2050, as they were in the year 2000. In the South America East Coast to POB trade, 39 percent of cargo tonnage will be carried by container vessels, 24 percent on product tankers, and 18 percent on bulk carriers. Some transport of bulk commodity on container vessels is reflected in the 2050 forecast. This relates to the overall effort to balance and properly match, as best as possible, the vessel movements. Over 72 percent of export tonnage to Eastern Europe will be on board bulk carriers. Imports from the Caribbean Basin will be mostly cement and sugar, thus over 50 percent of this tonnage will move on bulk carriers. Additionally, imported petroleum products (21% of total tonnage) will move on tankers. The inbound trades from the East Coast of South America shifts to petroleum products as crude producing countries refine an increasing amount of their output. However, the second largest trade lane from the Caribbean Basin to the Port of Baltimore is still dominated by crude petroleum through the year 2050. In the Northern Europe trade, 43 percent of total metric tonnage will be carried by vehicle carriers. This is in line with the fact that nearly half of this trade lane is devoted to passenger cars. The Baltimore to the Mediterranean trade will involve large moves of coal & coke. Nearly 75 percent of this trade's total tonnage is transported by bulk carriers. Over 65 percent of imports from Australia/New Zealand will move on bulk carriers. Nearly half of the Baltimore to Japan cargoes will move on bulk carriers, thus relating to the large moves of coal & coke to this destination.

**TABLE 18**  
**PORT OF BALTIMORE'S LARGEST TRADING PARTNERS FOR YEAR 2050 IN METRIC TONS AND SHIPTYPES**

Shiptype	Baltimore Vessels	Port of										Australia/New				Port of	Port of	Port of	Port of
		South America East Coast to Port of Baltimore	Caribbean Basin to Port of Baltimore	Baltimore to South America, E. Coast	Port of Baltimore to E. Europe	Port of Baltimore to Other Med	N. Europe to Port of Baltimore	Port of Baltimore to N. Europe	Port of Baltimore to Zealand to Baltimore	Port of Baltimore to S. Europe	Port of Baltimore to Japan								
Gen Cargo >10,000	AA	2,940,096	593,557	1,125,047	1,510,158	482,741	212,729	178,848	304,227	216,086	16,057								
Gen Cargo <10,000	AB	12,794	0	85	0	0	24,459	5,374	0	136	122								
Cellular 1000-2499 TEU	A1	1,441,431	6,339	205,947	0	1,380	92,043	135,147	8,671	278	251								
Cellular 2500-3999 TEU	A2	2,805,507	86,586	3,054,305	7,878	296,354	281,100	389,569	63,326	221,865	65,529								
Cellular 4000-5999 TEU	A3	2,048,442	47,707	1,798,419	10,124	165,863	351,523	679,032	36,833	179,365	148,637								
Cellular 6000-7999 TEU	A4	1,666,033	18,490	897,618	13,960	68,762	330,691	731,620	17,603	95,482	135,212								
Cellular >8000 TEU	A5	0	0	0	0	0	0	0	0	0	0								
RoRo >10,000	A6	346,441	0	349,151	623,644	56,269	625,750	709,271	65,793	80,065	11,146								
RoRo <10,000	AF	0	0	0	2	13,584	272	0	0	14,132	0								
Reefer	BA	6 889	2,260	0	0	0	1,888	382	54	0	0								
Bulk <20,000 DWT	DA	0	0	0	166	0	51	101	0	3,481	0								
Bulk 20K to 40K DWT	DB	1,010,304	5,264,181	227,618	5,103	948,777	28,460	18,335	0	70,501	0								
Bulk 40K to 80K DWT	DC	1,097,492	3,676,421	853,872	2,689,268	1,367,048	145,757	149,760	499,955	345,748	39,418								
Bulk 80K to 100K DWT	DD	385,587	592,811	219,060	1,466,389	440,635	38,245	48,491	293,465	163,798	13,557								
Bulk 100K to 175K DWT	DE	869,682	236,232	111,914	1,192,976	692,460	19,700	142,160	244,969	214,642	236,178								
Bulk >175,000 DWT	DF	501,913	36,392	20,475	322,386	360,844	3,621	88,574	67,136	97,133	168,124								
Combo <20,000 DWT	EA	0	0	0	0	0	0	0	0	0	0								
Combo 20K to 40K DWT	EB	0	0	0	0	0	0	0	0	0	0								
Combo 40K to 80K DWT	EC	0	0	0	0	0	0	3,419	0	0	0								
Combo 80K to 100K DWT	ED	0	0	0	0	0	0	1,903	0	2,032	0								
Combo 100K to 175K DWT	EE	0	0	0	0	0	0	10,471	0	16,366	0								
Combo 175,000 DWT	EF	0	0	0	0	0	0	7,374	0	11,478	0								
Tanker <16,500 DWT	FA	0	0	0	0	0	0	0	0	0	0								
Tanker 16.5K to 25K DWT	FB	0	0	0	0	0	10,611	0	0	0	0								
Tanker 25K to 45K DWT	FC	0	1,547,333	0	0	66,742	24,970	0	0	0	0								
Tanker 45K to 80K DWT	FD	0	1,158,094	0	0	37,155	26,972	44,997	0	176	0								
Tanker 80K to 160K DWT	FE	0	391,620	0	0	9,768	83,409	25,050	0	98	0								
Tanker 160K to 250K DWT	FF	0	80,773	0	0	1,611	42,806	6,585	0	26	0								
Tanker >250,000 DWT	FG	0	12,804	0	0	204	12,980	1,224	0	1	0								
Prod. Tanker <16,500 DWT	PA	0	0	0	0	0	0	0	0	0	0								
Prod. Tanker 16.5K to 25K DWT	PB	65,774	296,692	0	5,618	56	34,743	4,599	0	38	0								
Prod. Tanker 25K to 45K DWT	PC	1,509,807	461,861	47,045	3,128	31	42,218	41,900	0	164	14								
Prod. Tanker 45K to 80K DWT	PD	1,566,348	208,589	26,190	822	8	17,820	22,574	0	85	8								
Prod. Tanker 80K to 160K DWT	PE	1,967,891	59,560	8,165	153	2	4,915	6,953	0	26	0								
Gas Tankers	GA	0	0	0	0	0	1,995,040	870,315	0	0	0								
Vehicle Carriers	HB	0	0	0	0	0	204,843	0	0	0	0								
Other Ships	XX	797,275	0	0	0	0	0	0	0	0	0								
TOTALS		21,039,706	14,778,302	8,944,911	7,851,775	5,010,294	4,657,716	4,347,642	2,732,023	1,733,206	834,255								

## **Vessel Call Forecasts**

This section of the report describes the process used to forecast the vessel calls that were utilized in the simulation models to analyze with and without project conditions. As discussed in the previous sections, DRI produced forecasts of cargo carriage by vessel type based on forecasts from the World Sea Trade Service (WSTS) and World Fleet Forecast Service (WFFS). These were combined with WSTS forecasts for the Port of Baltimore and detailed vessel calls and sailing drafts derived from the Waterborne Commerce Statistics Center data (WCSC) and vessel entrance and clearance data plus vessel characteristics from Lloyds Maritime Information Services (LMIS) and Fairplay. The analysis also related the forecasts to inland distribution patterns derived from Journal of Commerce PIERS data (JoC) and Reebie Associates Transearch data. Finally the projected vessel calls by sailing draft were combined with the vessel movements by terminal and anchorage within the Port of Baltimore from the Baltimore Maritime Exchange (BME) database (which is discussed in Annex D). The BME database provided information on the arrival/departure patterns (C&D vs. Cape Henry) and the detailed terminal and anchorage activity utilized in the simulation models.

The forecasts of vessel calls were derived by applying the DRI WSTS forecast growth by commodity and trade partner to the commodities identified on each WCSC vessel call to and from the Port of Baltimore. This procedure produced an initial forecast of vessel calls by vessel type based on projected commodity growth. The results of the vessel call forecast based on cargo growth were then combined with the vessel type forecasts from the World Fleet Forecast Service in order to incorporate changes in activity levels by vessel type. The projected vessel calls by direction were then modified to reflect future ballast voyages necessary to accommodate the vessel calls required in the dominant direction of cargo carriage. The individual vessel calls from the WCSC database were also linked to the Lloyd's vessel characteristics and sailing drafts from entrance and clearance files. These data sources allowed the projected vessel calls to reflect vessel characteristics and sailing drafts. The

projected vessel calls by individual vessel type and sailing draft are included in Annex E. Table 19 below includes a summary of the projected inbound and outbound vessels calls.

**Table 19**

**PROJECTED PORT OF BALTIMORE VESSEL CALLS  
BY DIRECTION 1993 TO 2050**

<b><u>Direction</u></b>	<b><u>1993</u></b>	<b><u>2000</u></b>	<b><u>2010</u></b>	<b><u>2020</u></b>	<b><u>2030</u></b>	<b><u>2040</u></b>	<b><u>2050</u></b>
Inbound	2,208	3,429	4,793	7,667	10,435	14,595	20,323
Outbound	2,210	3,430	4,793	7,667	10,435	14,595	20,323

Annex E also includes a summary of total vessel calls by vessel type. Containership and tanker calls are projected to increase as a percentage of total vessel calls. Vessel calls by the General Cargo class and the "Other Vessel" class will experience the largest declines in share of total projected vessel calls.

By the year 2050, overall vessel calls are projected to increase approximately 9.2 times (not a compound annual factor) the base calls observed in 1993. The increase in vessel calls compares to increases in import tons (7.3 times) and export tons (3.2 times). Vessel calls increase faster than projected tonnage since vessel calls are required to serve the dominant direction of trade (imports in the base forecast). The growth in vessel calls is also due to the increase in share of containership calls which are growing faster (increased share) than the slower growing bulk trades. This translates into more calls, for a given amount of tonnage, than required of bulk and tanker services. In addition, ballast voyages are projected to increase with the increases in the vessel calls in the dominant direction. Calls can increase faster than tonnage where imbalanced trades are growing given the procedures utilized by DRI which first project vessel calls necessary to carry the projected cargo and then add the computed ballast voyages required to balance the vessel movements.

The projected vessel calls were utilized to drive forecasts of vessel movements by terminal area and anchorage within the Port of Baltimore. Vessel movements within the Port of Baltimore were based on the analysis of the BME database of vessel movements. In the base year the BME vessel movements were matched to the vessel calls identified from the WCSC databases. This allowed approaches via Cape Henry or the C&D Canal to be identified as well as the linkage of voyages to calls at the major terminals and anchorage areas. A summary of the vessel calls by terminal area is included in Annex F: VESSEL ACTIVITY - TERMINAL USAGE. The BME vessel movement data also provided the baseline information on vessel movements by terminal related to baseline vessel calls.

The DRI forecasts of vessel calls by sailing draft were determined to be the same for the with and without project conditions. This was based on a review of the channel depths for the with and without projects, which indicated that the vessel types and sizes calling the Port of Baltimore would not be altered by the with project changes in branch channel depth. This result reflected the constant main channel depth and the relatively small branch channel depth changes, which, combined with the constant main channel depth, were deemed to not contribute to changes in the vessel types and sizes calling the Port of Baltimore. As a result, the benefits measured for the with project condition are identified from the simulation models based on the efficiencies in handling the forecast vessel activity relative to the without project condition. Thus the baseline DRI projections of vessel calls by vessel type and sailing draft were utilized as inputs to both the with and without project simulations.

**ANNEX A WORLD SEA TRADE SERVICE FORECAST  
METHODOLOGY**



## ANNEX A

### WORLD SEA TRADE SERVICE FORECAST METHODOLOGY

#### Introduction:

The DRI World Sea Trade Service depends upon a complex set of models. International trade is modeled for individual products over time. Individual models of worldwide trade for more than 59 commodities are included in the general service. Specific forecasts showing inbound and outbound trade of OECD member countries, newly industrialized countries in Asia, ASEAN countries, and selected Latin American countries. At the present time there are 32 reporter countries in the system. For each of these countries a complete trade data base exists showing trade with all 56 partner regions or countries worldwide.

Forecasts are derived from a set of econometric and parameter models. Econometric models generally include both demand and price variables. Over the past seven years, DRI has refined these models so that they are generally robust and stable representations of global trade patterns. In general, price elasticities calculated are of the correct sign and size.

World trade models are commodity specific. They define the interaction of importers and exporters on a global basis. Unlike other attempts at world trade model development these models do not begin with a top down estimate of total trade demand but rather are built up, in logical steps, from demand and supply to partner regions. For the most part econometric models define import demand and export supply. Parameter models are used, in relationship with econometric models (for total demand from world for country  $i$ , commodity  $k$ , and partner  $j$ , as of time period  $t$ ) if separate econometric models are inappropriate due to the scarceness of the data available or a failure to find a statistically significant model using econometric techniques.

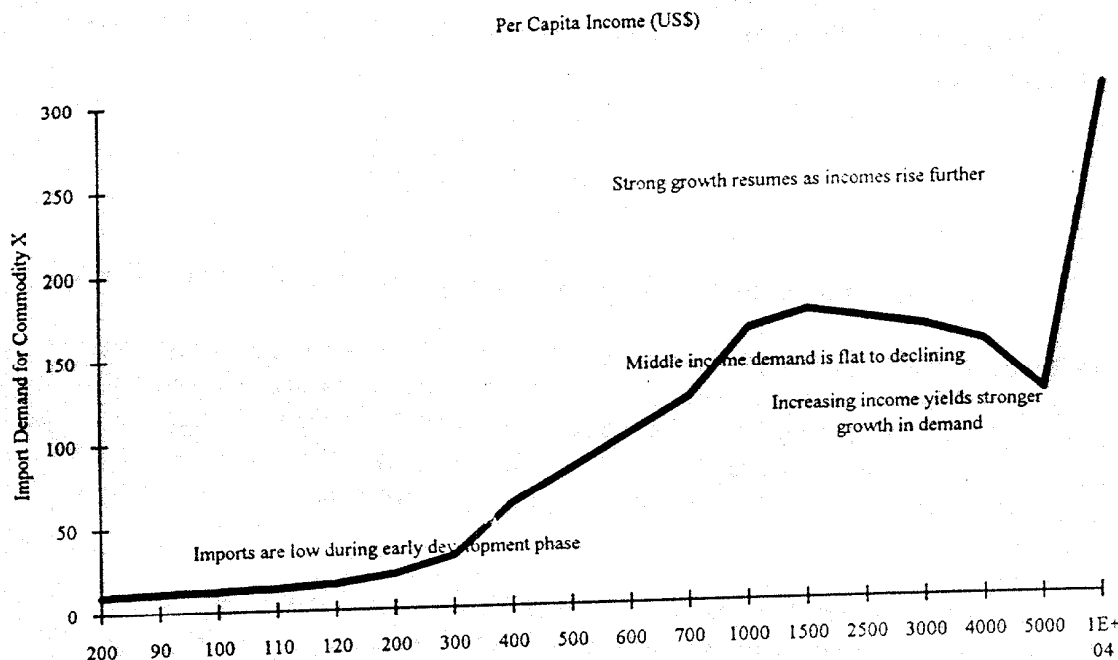
Imports and exports among the major developed market economy countries (32 reporter countries for which primary trade data are available) are balanced with exports flows to reporter countries and regions. The result is a forecast that takes into account both the past pattern of international trade from the perspective of the importer and the potential of individual exporters to improve their trade performance in these same markets as a result of changes in investments, relative wages, exchange rates and growth in total factor productivity.

Forecasts are based on estimates of macroeconomic variables drawn from DRI's extensive set of macroeconomic models (over 50 countries are modeled regularly as part of the DRI World Trade models, while depending upon macroeconomic factors, are not directly linked to country-specific trade forecasts. Despite the difference in approach we have found that the trade forecast -- developed from the collection of individual commodity forecasts covering reporter country trade to and from more than 56 partner regions -- tends to agree with the broadbased macroeconomic projection of trade.

## **Theoretical Framework: International Trade Life Cycle**

The underlying theory for these trade models comes from an understanding of the changing structure that is impacting world trade. As nations develop, they require different inputs. Moreover, the change from a goods-intensive to a service-intensive producer forces a shift in the pattern of trade. In general, DRI trade models are based on a theory of a long term product life cycle theory that is roughly generalized in the diagram below. When a country is poor and underdeveloped it can buy little from the international market. As it develops, however, demand will increase. The developing industrial base and the expanding consumer sector require inputs from outside to sustain development. Often in this phase the country is exporting low value manufactures or attracting foreign investments. Once development is in place, then the domestic market may begin to substitute for the foreign market. This substitution is often a result of foreign investors' having set up manufacturing facilities to export similar products and also to supply the local market demand that is now growing fast as a result of the economic activity. In this growth stage foreign demand declines for the product. When the country becomes advanced, it may reverse this pattern and begin to buy more from abroad. This shift is normally the result of the elimination of low value producers of these type products in the home market because of rising levels of wages which force manufacturers to shift to high value production. During this final phase, import demand will increase.

As we know to be true for many of the most advanced and wealthiest nations this final phase has started. Import demand rises faster than economic growth as foreign producers substitute for domestic producers who have shifted from less-valued to more-valued production. At that time, the imposition of trade barriers would be counter productive since the cost to the economy of rebuilding this lost industrial base (lost not necessarily to foreign competition but rather to costly capital and labor) may be higher than the gains associated with job creation.



### The Underlying Quantitative Model

The underlying quantitative model for exports and imports is a pooled cross sectional time series estimation procedure. The basic structure of this model is drawn from a somewhat traditional model for trade demand. In its simplest and most straight forward form, economists believe that changes in international demand can be related to changes in real income growth in the economy. We can hypothesize this model as follows:

$$M = f(Y) \text{ or } M = APM * Y,$$

where  $APM = \text{Average } M / \text{Average } Y$ .

The APM in the above equation can be simply interpreted to be the average propensity to import as income changes. But APM is not a static relationship. It changes over time -- for a country and for the world in general. As a country becomes more intensively involved in the world economy, the expected additional imports will diminish. Moreover the beta itself must depend upon the structure within the economy. In DRI's trade models we have abstracted a somewhat more complex form for this equation. We know that as nations develop, there has been a tendency to substitute demand for services for demand of products. This shift must necessarily impact the average propensity to import or if we transform this equation from a level to a flow, it becomes the marginal propensity to import, i.e., the change in imports relative to the change in income.

In the 1960s, 1970s, and 1980s, the trade intensity of most nations increased with the demand for traded goods declining as the demand for services increased. The APM may be divided into two parts:

$$APM = \frac{CG}{Y} \times \frac{M}{CG},$$

where CG is the consumption of traded goods defined by  $CG = PG - E + M$ .

The trade intensity measure,  $M/CG$ , moves towards 1.0 while the  $CG/Y$  has tended to decline over time. Thus the marginal change in the APM while increasing will gradually slow down over time. We know for most smaller countries in Western Europe the integration has already led to trade intensity measures that are approaching unity (1.0). Over the past thirty years nearly all growth has come in this ratio as the general trend for most countries for  $CG/Y$  is negative.

Income can also be divided into two parts: market size and wealth per capita. The shift in demand can be related to market size since larger markets tend to demand more of some products but also to yield economies of scale that allow home market production to substitute for foreign production. The wealth effect on trade is sometimes positive since wealthier markets attract more foreign suppliers; and sometimes negative as wealthier markets may demand products that cannot be produced inexpensively abroad (high technology imports relative to market size may be higher the less wealthy the market).

Using these relationships we can reform our model for imports to be as follow:

$$M = A (CG/Y)^{\beta_1} (M/CG)^{\beta_2} (N)^{\beta_3} (Y/N)^{\beta_4},$$

where A is the constant intercept,  $CG/Y$  is the average consumption of traded goods to income,  $M/CG$  is the trade intensity measure, N is market size (population), and  $Y/N$  is per capita income or wealth.

A similar structural model can be hypothesized for exports:

$$E = A (PG/Y)^{\beta_1} (E/CG)^{\beta_2} (N)^{\beta_3} (Y/N)^{\beta_4},$$

where A is the constant intercept,  $PG/Y$  is the average production of traded goods to income,  $E/CG$  is the trade intensity measure, N is market size (population), and  $Y/N$  is per capita income or wealth.

Since we have formulated our model in terms of a multiplicative relationship adjusted by the estimated values for the betas ( $\beta$ ). This form can be transformed using a logarithmic transformation so that the betas ( $\beta$ ) are, in fact, point elasticities. If all betas ( $\beta$ ) were approximately equal to 1.0 then the equation would be close to the original specification whereby imports are a function of the average propensity to import and income.

The current version of the DRI World Trade Model embodies structural relationships for consumption and production. The import model, however, has been formulated to mirror more correctly the short term patterns in market demand as reflected by the demand for consumer products (personal consumption expenditures) and investment goods (business fixed investment spending). A relative price term has also been introduced, as well as a commodity specific forecast of total consumption. Commodity specific consumption and production is introduced using broader based categories developed by DRI from OECD and United Nations data on production at the four digit ISIC group level of detail.<sup>1</sup> Per capita wealth is used in the export equation along with other factors such as productivity growth, relative wages, and prices. In both export and import models relative import and export prices are included. Population growth tends to be slow across time and is better captured by an individual country intercept than by a cross-country variable related to population size.

#### **Translating Nominal U.S. Dollar Trade into Real Volume Trade Using Price and Exchange Rate Deflators**

One of the most difficult to solve problems involves the question of intertemporal and intercountry comparisons of trade volumes. Econometric models are best described in terms of real volume rather than nominal value. Prices are both descriptive of the current value and also structurally important describing behavior of consumers as they change. Moreover, for internationally traded goods finding a common measure of purchasing power and the best procedure to judge volume changes is key to describing real activity in international trade. Since most trade data are stated in terms of a single denominator currency (U.S. dollars), changes in the local currency/dollar exchange rate can suggest that trade is growing faster or slower than is the case. A revalued currency against the dollar will suggest that dollar based trade is lower than it is in terms of trade volume since for the same amount of local currency more products can be purchased. Similarly, if the value is higher due to the devaluation of the currency against the dollar the actual volume of goods shipped may, in fact, be less.

A standardized approach to adjustment of trade value to volume has been developed that takes into account both commodity prices (in terms of U.S. dollars as measured using SITC based export and import price indices) and cross-exchange rates. Individual country differences in price inflation relative to U.S. prices are taken into account using export price indices. Two principles have guided our approach:

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<sup>1</sup> International Standard Industrial Classifications exist at the 2, 3 and 4 digit levels of detail. Generally, data are available from the OECD at the 4-digit ISIC category for most OECD member countries. Less detailed data are available from the United Nations. This source is generally several years out of date and there are often gaps in the coverage (many countries do not provide full detail). DRI has developed specialized interpretative models to fill in data where necessary. Apparent consumption is constructed from ISIC production data and ISIC level aggregates for international trade to and from the world. Specialized models for relating production and consumption to trade using a unified, input-output model to relate intermediate demand across product categories, have also been developed so that forecasts for both production and apparent consumption can be introduced into the World Trade Model.

1. Real changes in commodity prices should be captured;
2. Exchange rate changes should not be introduced mechanically, in order to avoid assuming that the full effect of the change in international prices is passed onto buyers by sellers.

The lack of fully consistent, trade-specific prices for commodities included in our studies has led to the development of a hybrid methodology using United States price statistics, exchange rates, and general export price indices. These synthetic measures are specific to OECD countries, specific to the commodities analyzed, and also specific to the direction of the trade.

We depend upon United States Department of Labor price indices for U.S. imports and exports. These indices are developed using survey data from U.S. importers and exporters, are commodity specific, and are available quarterly. They are not, however, specific to the direction of trade. Thus to understand the effect of U.S. dollar changes on Japanese export volumes we need to abstract from these commodity-specific U.S. dollar price indices by including the impact of changes in exchange rates and general export price trends in Japan.

In general for OECD country exporters U.S. export commodity price indices for historical data and DRI developed price forecasts for forecast periods are used. For exports of LDC regions, U.S. import commodity price indices are applied. For imports from OECD regions, we develop synthetic import price indices, specific to commodities, importing countries, and exporters -- i.e., for the French imports of product  $k$  from Japan, we use Japanese export prices to the world of product  $k$ . When applied to the dollar denominated (at current dollar/franc exchange rates) value for French imports the result is a volume measure of French imports from Japan in constant 1980 U.S. dollars and exchange rates.

While the system is somewhat synthetic -- using U.S. dollar commodity indices rather than country specific indices -- it is also dynamic in that it takes into account intercountry differences in price inflation. The generalized export price term for any reporter country  $i$  and any commodity  $k$  is :

$$\text{Export Prices } jk = \frac{\text{Index of Exchange Rates } j \text{ (1980 = 1.0 based on LC/\$)}}{\text{BLS Commodity Price Export } k \text{ (1980 = 1.0) } * (\text{Export Price } j \text{ (1980 = 1.0) } / \text{GDP Price Deflator U.S. (1980 = 1.0))}.$$

A currency that is revaluing relative to the dollar has an index that is declining. The adjustment of the commodity price for product  $k$  is designed to relate the export price of the exporter to the U.S. general price level. For example in the mid-1980s, the yen appreciated against the dollar the Japanese export price declined (in yen terms). A decline in the export price counters the appreciation in the yen/\$ exchange rate (fewer yen per dollar).

To translate French imports from Japan into real import volumes we apply this export price relationship against the nominal dollar imports of France from Japan, i.e.:

$$RM_{ijt} = M_{ijkt} \times \text{Export Price}_{jk}$$

where  $RM$  is real imports,  $i$  is France,  $j$  is Japan, and  $k$  is any commodity category.

The index of exchange rates translates the nominal dollar trade into real dollars at a fixed exchange rate. The real imports are then divided by the commodity price adjusted by the differential rate of inflation between Japan and the United States (the basis for the commodity price data).

These synthetic measures capture some of the dynamic movement in prices paid by importers. Given the importance of the U.S. dollar, the American market, the commodity price shifts apparent and as reflected in U.S. SITC-based price statistics, appear to be reasonable proxies for true, commodity-specific and country-specific price series. Even if selected trade-based commodity prices were available for other reporters, differences in definitions would lead to difficulties. Thus this standardized method provides a good universal translation for all trade data no matter what the source.

In the case of trade between OECD reporters and developing countries, imports are deflated using a combination of U.S. import prices and exchange rate adjusted import prices. It is assumed that to remain competitive, export prices and exchange rates are adjusted within the larger U.S. market. To a limited extent, however, a revaluation of a currency against the dollar may be reflected in higher export prices and, as a result, imports from that country -- when nominal dollar import values are restated in real volume measures -- will show a smaller growth in terms of volume. The degree of adjustment included is, however, generally small since less developed country exporters are very sensitive to how changes in their export prices affect their export market shares.

### The Structure of the Model

Each trade model includes a fully described set of historical and trade data for the 32 reporters trading both exports and imports with the 54 partner regions. For some reporters, such as the United States, Canada, Germany, France, United Kingdom, Italy, Japan, Hong Kong, Korea, Taiwan, India, Malaysia, Philippines, Thailand, Singapore, Indonesia, Brazil and Mexico there is a fully described matrix of bilateral trade flows among these countries. Thus, within the system, there exists German exports to the United States, United States imports from Germany (exports from the German trade data and imports from the U.S. trade data) as well as United States exports to Germany and German imports from the United States.<sup>2</sup> In the case of other regions data exists for imports of each reporter from nonreporter partner groups or regions. Thus, Swedish trade with Other Northern Europe exists but not Swedish trade with Norway (a member of Other Northern Europe).

<sup>2</sup> For the three NIEs, Southeast Asia, India, Mexico and Brazil exports and imports are the same. Therefore, Brazilian exports to the United States are the same as United States imports from Brazil, since for these countries we have chosen to utilize U.S., rather than Brazilian data.

Reporter countries are those for which reliable detailed trade data and DRI macroeconomic forecasts are available regularly (see List A). Countries highlighted in italics on this list are those for which there bilateral trade is feasible. The 32 countries included in the current system cover roughly 90% or more of world trade. Partner countries are destinations and sources for trade for each reporter country (see List B).

### **The Process: The Multistage Approach to Global Trade Forecasting**

Econometric models for imports and exports are based on a pooled-cross-sectional time series model with individual country intercepts (this is essentially the covariance model). Pooled cross-sectional models combine information on many countries over a relatively shortened time span, rather than rely upon country-specific time series models over longer time periods. Because international trade data are consistently available only from 1978 (at revision 2 of the UN's Standard International Trade Classification), and from 1988/89 using SITC Revision 3 (or harmonized codes), pooled cross-sectional time series models offer the best approach to trade analysis. Moreover, cross sectional models when combined with time series models, are capable of predicting both short-term patterns and long-term trends.

Cross country models are based on a theory that suggests patterns of future trade can be determined by observing the relationship between market size and economic wealth of more than a single country. Thus the pattern of trade of an advanced, service dominated economy like the United States may serve as a template for future patterns of trade for other countries, not as large or as wealthy.

Currently models are based on data starting in 1982 and running through 1993. As additional monthly data are available for selected reporters, they are included as annualized data and models are fully restated each quarter. To minimize possible differences in data between outbound and inbound trade on similar routes for non-OECD reporters, trade with OECD countries and regions data based on OECD reporter country statistics are used.<sup>3</sup> For example, Italian imports of steel from Taiwan are based on Italian imports from Taiwan and not Taiwanese exports to Italy.

The econometric relationships vary depending on whether import or export data are used. Most of the variance, however, is explained by the more general economic variables for the entire set of 22 OECD countries included in the estimating equation. To assure that noneconomic factors that affect the propensity of a country to import or its ability to export a specific product, individual country intercepts are also calculated. The form that these intercept terms take -- i.e., the independent variable that they modify -- differs depending if it

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<sup>3</sup> Data for non-OECD countries are drawn from a variety of sources. United Nations data are generally only available at the 4 digit level of product detail for most countries. More detailed data is available for Taiwan and Hong Kong, while data for Korea has varied in quality over time. To minimize possible discontinuities, it has been generally decided to use OECD Trade Series C data as a proxy for LDC data to and from OECD members. LDC data are, however, used for non-OECD trade routes.

is an export or an import model. Thus for each country, the econometric equation is made up of three parts:

1. Coefficients specific to that country;
2. Coefficients common to the set of countries, and
3. Country-specific intercepts.

In general the equation has the following form:

$$M_{jk} = \phi k + \beta X + \omega X_i$$

where  $i$  is the reporter country for which there is a single intercept term for each ( $\phi$ ),  $k$  is the product type and  $j$  is the partner region. The beta ( $\beta$ ) represents the generalized coefficients jointly estimated, while  $\omega$  is the coefficient for reporter and region specific variables. Generally, region-specific variables are used for differential price effects. We have found, for example, quite different reactions to changes in import prices among countries and regions.

## Econometric Variables Included in the World Trade Models

### Imports of OECD Reporters from Partner Regions

Import equations may depend upon:

- o Traded goods consumption as a share of Gross National Product;
- o Import share of traded goods consumption;
- o Personal consumption expenditures;
- o Investment expenditures;
- o Import prices (the adjusted local currency price after taking into account changes in local/\$ rates, cross rates of exchange, and U.S. commodity price trends);
- o Import prices for specific importing regions (U.S., Japan, and Northern Europe);
- o Consumption of commodity;
- o Production of commodity ;
- o Country specific intercepts;

and

- o Country-specific adjustment variables (for refining estimates using a two-stage estimation procedure).

### **Exports of All Reporters to Partner Regions**

Exports are a function of the following variables:

- o Goods production share of Gross Domestic Product;
- o Exports of merchandise, adjusted for service component, as a share of production of goods;
- o Local currency wages;
- o Real factor productivity;
- o Investment share of output;
- o Exporter's price (includes adjustments for commodity prices, general export price trends relative to U.S. price trends, and exchange rates) in importer's currency (index);
- o Production of commodity ;
- o Country specific variables measuring demand growth and relative prices in importing regions,

and

- o Country specific adjustment variables (developed using the iterative method of model adjustment).

### **Imports of Non-OECD Partners from All Reporters**

Import demand for non-OECD partners are based on a pooled-cross-regional time series model. Total exports of all OECD and non-OECD reporter countries to each partner region are used as dependent variables in this model. It thus captures the dynamic nature of trade with newly industrializing nations. This model reflects the changing demand structure of developing nations. The coefficients reflect the shift that naturally occurs as a nation moves from complete dependence on foreign sources of supply to partial dependence and finally to exports (with a net trade balance that shifts from negative to positive as exports outstrip imports).

The following regional variables are used in this sub-model:

- o Population size (the market to be reached);
- o Per capita GDP (the region's wealth);
- o Long term debt outstanding;
- o Relative prices -- a combination term combining export prices and exchange rate movements;
- o Consumption estimates for commodity;
- o Region-specific coefficients for Total Imports;
- and
- o Region specific intercepts (noneconomic factors affecting imports from OECD).

#### **Integration of Econometric Forecasts with Noneconometric Trade Results**

As discussed above, the World Trade Model has to combine elements of both methods to insure that results are reasonable estimates of future patterns of growth. To do this the system uses a weighted distribution of estimates for trade from the stochastic propensity and econometric models.

Because of the large number of trade flows forecast and their interdependence, it is critical that the world trade models incorporate internal tests and limits to insure that valid, reasonable forecasts are developed. Since logarithmic forms used in the econometric models are sometimes explosive, limits are imposed in the models assuring the quality of forecasts not singly, but rather for all countries and regions included in the modeling system.

The testing is done through an expert system. The expert system works with a number of simple rules that continuously check results against past trends in trade. Whenever a preliminary flow is assumed to be moving erratically, an alternate, more stable method is substituted.

Generally, we have developed a hierarchy of choice. If there are sufficient observations, then econometric models are estimated. If, however, there are insufficient degrees of freedom for accurate statistical models to be developed, then alternative, noneconometric approaches must be used. If the volume of trade is particularly small or erratic, then noneconometric approaches are again favored.

If an econometric model is sufficiently accurate -- judged by the Standard Error as an initial test, then its forecasting accuracy is tested over the historical period (1982 through 1992) in order to determine on which countries in the cross-country sample, trade forecasts should be based on econometric models and for which propensity models should be used.

To accomplish this an average error over the period (the cumulative average percentage deviation of the forecast from the actual) for each reporter is estimated. The pooled cross-sectional model technique allows the easy separation of each of the 32 reporters once the multi-country model is estimated. If the standard error for country  $i$  from region  $j$  for product  $k$  calculated over the forecast interval (1982-92) over a pre-determined limit -- MaxError -- then the propensity model forecast is used in place of the econometric forecast. When the standard error for the country is less than MaxError, but greater than MinError, then the noneconometrically determined estimate of trade is used. A formula is used to fix the weights:

$$\text{ADJUST} = (\text{Standard Error} - \text{MinError}) / (\text{MaxError} - \text{MinError})$$

From this formula we can see that if the Standard Error is close to MinError, then the majority of the influence will be derived from the econometric specification. If, on the other hand, the Standard Error is closer to the MaxError then the opposite is the case.

If the standard error of the equation is less than the MinError, then only the forecast, adjusted by the estimated standard error for the flow (from the econometric model), is utilized. In this case, the forecast depends solely on the econometric results.

To insure that the best estimation and forecasting approach is used to project trade, a built-in expert system is used by the model software. The accuracy of the econometric model projection over the historical period is used as a measure of success. It determines when an alternative, noneconometric, approach should be used to project trade flows.

#### **Parametric Models for Trade:**

##### **A Noneconometric Approach to Forecasting Trade Flows**

In cases where the econometric approaches may not be sufficiently accurate (generally occurring when there is an insufficient number of observations), stable, noneconometric estimates of trade flows are developed using average patterns associated with historical periods. Such methods must, necessarily, choose criteria on which to base estimates, and such estimates are typically less volatile than the actual data they represent.

Noneconometric estimates are based on special propensity model that relates trade of a partner to total trade:

$$\text{APM}_{ijkt} = \text{M}_{ijkt} / \text{M}_{i,\text{World},kt}$$

$GRAPM(ikj) = \%Growth(APM(ikdt, 1985-1992)),$   
 where %Growth is the compound annual rate of growth for the period 1985-92, so  
 that

$$M(ikd, t+1) = (APM(ijk_t)) * (1 + .01 * GRAPM(ijk)) * M(i, World, kt+1),$$

where M is imports of country *i*, of product *k*, from region *d*, for time *t*; APM is the propensity to import *k* from *j* relative to *k* from World for all reporters *i*; GRAPM is the growth rate of the APM; and *M(ik, World)* is the imports of the commodity from the world.

If the APM were held constant in the forecast interval then the growth would be limited to the growth from the world for commodity *k*. To include the true change that has occurred, a growth parameter is introduced for the APM that reflects the change in the APM over the historical period and the projected growth in the APM into the forecast period. This growth is, however, constrained by a limit on the amount of growth allowed.

Thus the parameter model assumes that the market share, as measured (in the case of imports) by the ratio of imports from one subregion *j* relative to imports from the world, will change slightly based on the general direction of change recorded in the past. If the market share is growing then the share is growing relative to the imports from the world. Imports from the world is based on an econometric model.

### Integration of Import and Export Estimates

This marks the end of the first stage of forecast development where preliminary forecasts of exports and imports are developed. Now in the second stage these preliminary, independent estimates are merged to yield a jointly consistent forecast. The sum of the parts in the model -- i.e., the demand by regions -- is compared to the demand estimated by the model's equations from all sources (from the OECD, from the LDC, and from the World). For each commodity these other estimates serve as additional information and are averaged with the forecasts developed by summing the regional values.

The model also integrates information on import demand with information on export supply. For intra-OECD trade, the import demand forecast serves as the template and the export supply models are used to measure market shares of individual reporter countries. Through a series of steps the export and import estimates -- for countries and regions -- are merged together.

The DRI World Trade Modeling System fits together structurally, not through a set of interlocking bilateral relationships, but through a set of interrelated regional/country relationships. For example imports of the United States are defined by the import demand models, i.e., imports from Japan, from Canada, from Germany, from Other N. Europe, from East Africa. United States imports from the OECD is the collection of the pieces of OECD

compared to U.S. imports from the OECD (an aggregate model estimate). Exports to the United States by OECD reporters is separately developed.

While it is possible that the German export market share in the U.S. market (from the export model) when multiplied by the aggregate U.S. import from All OECD yields in the forecast interval a reasonable estimate comparable to the U.S. import from Germany (one partner region within the OECD partner region set), there is no guarantee that they will be the same. To insure that they are, a separate adjustment procedure is applied in which the forecast pattern for import demand from Germany is given a 75% weight and the forecast Germany exports to the U.S. is given a 25% weight. The revised U.S. import from Germany and German exports to the U.S. for commodity  $k$  will then have the same growth pattern into the forecast interval.

### **Summary**

World Trade Models are based on an integrated framework that analyzes data for 32 countries, exports and imports, with more than 54 major import or export regions/countries. At the present time there are 59 individual commodities for which trade models exist. At the present time the system includes information on over 200,000 separate trade flows worldwide.

Commodity specific forecasts are developed based on a combined econometric and average propensity framework where exports and import flows are fully integrated to insure global consistency. All forecasts are based also on the latest macroeconomic model variables related to patterns of trade appropriate to the commodity being traded.

Trade forecasts are updated quarterly using monthly data available for 12 countries (soon to be upgraded to 20 countries). Annual data are updated as available from the OECD Trade Series C data base. At the present time annual information through 1993 is included, with monthly supplements providing 1994 data for selected countries. For estimates of current year data, a weighted average of actual and forecast data are used.

**List A: Reporter Countries included in World Trade System**

**MAJOR INDUSTRIALIZED REPORTER COUNTRIES**

<i>Australia</i>	<i>Austria</i>
<i>Belgium</i>	<i>Canada</i>
<i>Denmark</i>	<i>Finland</i>
<i>France</i>	<i>Germany</i>
<i>Greece</i>	<i>Ireland</i>
<i>New Zealand</i>	<i>Italy</i>
<i>Japan</i>	<i>Netherlands</i>
<i>Norway</i>	<i>Portugal</i>
<i>Spain</i>	<i>Sweden</i>
<i>Switzerland</i>	<i>Turkey</i>
<i>United Kingdom</i>	<i>United States</i>

**NEWLY INDUSTRIALIZING ASIAN DEVELOPING**

<i>Hong Kong</i>	<i>Taiwan</i>
<i>South Korea</i>	

**SOUTHEAST ASIAN DEVELOPING NATIONS**

<i>Philippines</i>	<i>Indonesia</i>
<i>Thailand</i>	<i>Singapore</i>
<i>Malaysia</i>	<i>India</i>

**LATIN AMERICAN COUNTRIES**

<i>Brazil</i>	<i>Mexico</i>
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## List B -- Partner Regions in the World Trade Model System

WORLD --- All countries including Socialists.

OECD --- All 24 members of the OECD.

NE --- Northern European Countries

FRANCE  
GERMANY  
UNITED KINGDOM  
OTHER N. EUROPE

SEU --- Southern European Countries  
ITALY  
OTHER S. EUROPE

JAPAN --- Japan

CANADA --- Canada

U.S. --- United States

AZ/NZ --- Australia/New Zealand

AUSTRALIA  
NEW ZEALAND

LDC --- Less Developed Countries

LATIN AMERICA

WLA - Western Latin America

ELA - Eastern Latin America

ARGENTINA

BRAZIL

OTHER E. LATIN AMERICA

CLA - Central America, Mexico, and  
Caribbean Islands

MEXICO

OTHER C. LATIN AMERICA

MEDITERRANEAN/PERSIAN GULF

MED - All countries bordering on the Mediterranean  
Sea including countries in North Africa, Egypt, Middle East

PG -- All countries bordering on the Persian Gulf

SAUDI ARABIA

OTHER PERSIAN GULF

IS -- India, Pakistan, Bangladesh, Afghanistan, Sri Lanka

INDIA

OTHER INDIAN SUBCONTINENT

FAR EAST

NICs -- Newly Industrializing Countries in Asia

KOREA  
TAIWAN  
HONG KONG

SEA -- Countries in Southeast Asia (members of ASEAN)  
SINGAPORE  
MALAYSIA  
INDONESIA  
PHILIPPINES  
THAILAND

CHINA -- Including North Korea and Mongolia

AFRICA

SAF -- Southern Africa including Angola, Zambia, Zimbabwe, Malawi,  
and South Africa

EAF -- East Africa including Kenya, Ethiopia, Uganda

WAF -- West Africa including Ghana, Togo, Nigeria

EASTERN EUROPE -- All countries in Eastern Europe including  
the Former Soviet Union and former Yugoslavia  
FORMER SOVIET UNION  
OTHER E. EUROPE

## Commodity Descriptions and Codes

<u>Commodity</u>	<u>Description</u>	<u>SITC Rev.2 Categories</u>
WST1	Live animals	00
WST2	Meat, fish and dairy products	01, 02, 03
WST3	Fruits and vegetables	05
WST4	Grain, animal feedstuffs	041 thru 045, 08
WST5	Sugar	06
WST6	Flour, food preparations, beverages & tobacco	046 thru 048, 07, 09, 11, 12
WST7	Animal skins, textile fibers and waste	21, 26, 29
WST8	Oil seeds	22
WST9	Animal and vegetable oil and fats	4
WST10	Rubber	23
WST11	Lumber, plywood and processed wood	24, 63
WST12	Pulp and waste paper	25
WST13	Phosphates	271.3
WST14	Cement, lime, stone, and crude materials	27 (except 271.3), 661
WST15	Manufactured fertilizers	56
WST16	Iron ore	281
WST17	Bauxite and non-ferrous ores	287
WST18	Other ores and scrap	282, 286, 288, 289
WST19	Coal and coke	32, 335.42
WST20	Crude petroleum	333
WST21	Other petroleum products	334, 335 (except 335.42)
WST22	Natural gas	341
WST23	Liquid bulk chemicals	511
WST24	Other chemicals	512 thru 516, 52, 53
WST25	Pharmaceuticals, toiletries	54, 55
WST26	Explosives, plastics, and other chemical prod.	57, 58, 59
WST27	Leather, rubber, and leather products	61, 62, 65 (except 658, 659)
WST28	Paper and paperboard	64
WST29	Other non-metallic mineral and metal manufactures	66 (except 661, 665, 666), 69 (except 696, 697, 699.1, 699.2, 699.3)
WST30	Iron and steel	67
WST31	Non-ferrous metals	68
WST32	Heavy industrial machinery	711, 712, 714, 718, 721, 725, 728, 736, 737
WST33	Light industrial machinery	713, 716, 724, 726, 727, 741, 742, 743, 745, 749
WST34	Heavy transportation & construction equipment	722, 723, 744, 782, 783, 786, 791
WST35	Automobiles	781
WST36	Motorcycles, automotive parts	784, 785
WST37	Aircraft and ships	79 (except 791)
WST38	Electrical equipment and parts	75, 76, 77

<u>Commodity</u>	<u>Description</u>	<u>SITC Rev.2 Categories</u>
WST39	Consumer goods, misc. manufacturing	658, 659, 665, 666, 696, 697, 699.1, 699.2, 699.3, 8
WST40	Commodities and transaction, nes.	9
WST41	Semiconductors and electrical parts	776, 778
WST42	Computers	752
WST43	Internal combustion engines and transmission shafts	713, 749.3
WST44	Automotive parts	784
WST45	Consumer audio and video	761, 762, 763
WST46	Office equipment	751
WST47	Electric power machinery and equipment	771, 772, 773
WST48	Household appliances	775
WST49	Textile furnishings	658, 659
WST50	Apparel and clothing accessories	84
WST51	Footwear	851
WST52	Scientific equipment	871, 872, 873, 874
WST53	Misc. light industrial machinery	716, 724, 726, 727, 741, 742, 743, 745, 749 (except 749.3)
WST54	Motorcycles and cycles	785
WST55	Misc. telecom and electronic equipment	759, 764, 774
WST56	Misc. consumer goods	665, 666, 696, 697, 699.1, 699.2, 699.3, 81, 82, 83, 88, 89
WST57	Engines and motors	714
WST58	Misc. heavy industrial machinery	711, 712, 718, 721, 725, 728, 736, 737
WST59	Pulp	251 (except 251.1)
WST60	Waste paper	251.1
WST61	Textile yarn and fabrics	651, 652, 653, 654, 655, 656, 657
WST62	Leather and rubber products	61, 62
WST63	Non-metallic mineral manufactures	66 (except 661, 665, 666)
WST64	Other metal manufactures	69 (except 696, 697, 699.1, 699.2, 699.3)
WST65	Meat, fish and dairy, requiring refrigeration	01 (except 014), 022.3, 022.41, 023, 024, 025, 034, 036
WST66	Meat, fish and dairy, not requiring refrigeration	014, 022.4 (except 022.41), 035, 037
WST67	Fruits and vegetables, requiring refrigeration	054.4, 054.59, 054.61, 054.84, 054.88, 057 (except 057.52, 057.6, 057.71, 057.72, 057.75, 057.79, 057.96, 057.99), 058.5, 058.61, 058.62
WST68	Fruits and vegetables, not requiring refrigeration	054.1, 054.2, 054.51, 054.62, 054.81, 054.82, 056, 057.52, 057.6, 057.71, 057.72, 057.75, 057.79, 057.96, 057.99, 058.2, 058.3, 058.63, 058.64, 058.9
WST69	Refined petroleum products	334
WST70	Residual petroleum products	335



## **ANNEX B WORLD FLEET FORECAST SERVICE METHODOLOGY**



## ANNEX B

### WORLD FLEET FORECAST SERVICE METHDOLOGY

#### Introduction:

The demand side used for forecasting ships in the World Fleet Forecast Service (WFFS) is supplied by the World Sea Trade Service (WSTS). WSTS produces trade forecasts by commodity and by trade route and these forecasts are then combined with ship characteristics and ship movement data to produce a fleet forecast by vessel type and by route. To produce the fleet forecast, the model goes through the following steps:

1. The WSTS forecast is allocated to the 38 vessel types and sizes in the WFFS system by trade route.
2. For each trade route, the model sums the trade moving on each vessel type to produce the total amount of trade moving on each trade route by vessel type.
3. The capacity (in DWT) needed to carry the cargo by trade route and by vessel type is then computed.
4. The number of voyages needed to carry the computed capacity is then calculated.
5. The number of voyages is converted to shipyears to give an approximation of the number of ships needed to carry the cargo per year.
6. Finally, the shipyears are adjusted to account for ballast voyages or voyages needed to reposition ships.

Each one of these steps, as well as the inputs to the model, is discussed in more detail below.

#### Model Inputs:

The two areas of model inputs are the WSTS cargo forecasts and the ship characteristics and movement files. WSTS forecasts trade by 40 commodity categories for approximately 700 trade routes. WSTS embodies a global approach in that, for example, one must look at world trade to see how the U.S. competes with other countries to forecast U.S. trade.

The ship characteristics are based on 1995 observed characteristics. They are collected by trade route and cover the following concepts:

**Ship Capacity:** Total observed DWT capacity by shiptype travelling on each route for the year 1995.

**Maximum Load Factors:** The percent of the DWT capacity which can be used for allocation of cargo.

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<b>Number of Voyages:</b>	The observed number of voyages by shiptype on a particular route in 1995. In the case where a ship travels to more than one region on a trip (i.e. leaves Rotterdam and travels to Halifax and Boston before returning to Europe), the number of voyages depends on the number of regions in which the ship stops. In the Rotterdam to Halifax to Boston example, one voyage would be recorded for North Europe to East Canada and one voyage would be recorded for North Europe to North Atlantic U.S. So as not to forecast a surplus of ships in such cases of multiple voyages being recorded on one trip, a reallocation factor is calculated as described below.
<b>Time Spent in Port:</b>	Average number of days spent in port in each region by vessel type.
<b>Average Design Speed:</b>	Design speed based on Lloyd's Registry data.
<b>Average Actual Speed:</b>	Average speed observed by vessels travelling on that route.
<b>Distance:</b>	Number of miles from coast A to coast B for the route. This number may differ by vessel type for a route depending on the routing of the particular vessel type (i.e., some of the large vessels may not be able to go through a canal and must take a longer routing).
<b>Canal Days:</b>	Number of days waiting to pass through a canal.
<b>Off-Hire Days:</b>	Average number of days per year which a ship is off-hire. WFFS assumes 15 days per year.
<b>Reallocation Factor:</b>	This is a factor which compensates for a ship which may unload and load cargo at more than one WFFS region on a trip. For example, the around-the-world container ships load and unload cargo at a number of different regions on their trips around the world. If a ship moves from the Arabian Gulf to the U.S. Gulf coast and unloads all of its cargo, the reallocation factor of 1.0. If it unloads 50 percent of the cargo on the Gulf coast and 50 percent of the cargo on the South Atlantic coast, the reallocation factor would be 0.5 on the Arabian Gulf to U.S. Gulf route, as well as the Arabian Gulf to U.S. South Atlantic coast.

The above factors constitute the inputs to the WFFS model.

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## Model Structure

### *Step 1*

The first step in producing the fleet forecast is to allocate the 40 WSTS commodities across the 38 WFFS shiptypes. This is done for each route in the WFFS system and for each year being forecast.

The shiptype allocation is based on historical data when available. Lloyd's Maritime Information Services provides the expertise on the shiptype allocations. A matrix is produced for each route for each year which looks similar to the example below.

### **Example**

#### **Shiptype**

<u>Commodity</u>	<u>AA</u>	<u>AB</u>	<u>AC</u>	<u>AD</u>	<u>AE</u>	<u>AF</u>	<u>BA</u>	<u>DA</u>	<u>...</u>
WSTS 1	300	0	20	0	500	0	0	0	...
WSTS 2	20	0	200	0	0	0	0	0	...

The letters in the example represent the different shiptypes and the commodities are the 40 WSTS commodity categories.

### *Step 2*

Each of the allocation matrices is summed to produce a total amount of cargo being carried by shiptype. The total cargo by shiptype in 1995 (the base year for the ship characteristics data) is compared with the shiptype capacity on each route to be sure that more cargo has not been allocated than capacity is available. If there is not enough capacity on a shiptype to carry the allocated cargo, the cargo allocation in Step 1 is reviewed for that route and adjusted accordingly.

### *Step 3*

Once the cargo has been allocated by shiptype by trade route by year, the total capacity needed to carry that cargo can be calculated. The capacity required depends on a key assumption -- capacity utilization. Different scenarios can be run using different capacity utilisation assumptions. If a 90 percent capacity utilization assumption is assumed:

$$\text{Required Capacity} = (\text{Cargo}/.90)/\text{Load Factor}$$

The maximum load factor is the percent of DWT capacity (by shiptype) which can be used for cargo. The required capacity computed above is the true DWT capacity needed to carry the allocated cargo at a 90 percent capacity utilization rate.

### *Step 4*

The next step is to calculate the number of voyages needed to carry the allocated cargo. The projected voyage capacity is divided into the forecast to compute voyages. This average capacity per voyage is increased over the forecast period to accommodate the larger ships coming on line. Therefore, for a single route, single year and single shiptype:

$$\text{Forecasted Voyages} = \frac{\text{Forecasted Capacity} * (1995 \text{ Voyages}/1995 \text{ Capacity})}{\text{Percent Increase}}$$

#### *Step 5*

Once the voyages are forecasted, the number of shipyears required to make those voyages can be calculated. A shipyear can be defined in terms of the cargo a ship can carry in one year. The cargo carriage will vary as a function of speed, time in port, off-hire days and days spent waiting to go through a canal.

Conversely, one can look at the number of shipyears required to carry the specified cargo volumes. Since the WFFS system is a route based model, it looks at the number of shipyears by shiptype on each route as follows:

1. Calculate the number of days of one voyage for each route.

$$\# \text{ days per voyage} = .5 * \text{time on coast A} + 5 * \text{Time on coast B} + \text{Canal days (if applicable)} + (\text{Distance in miles}/\text{Average Actual Speed in Miles per Day})$$

2. Calculate number of shipyears per voyage.

$$\# \text{ shipyears per voyage} = \# \text{ days per voyage} / (365 \text{ days per year} - \text{Off-hire days})$$

3. Calculate the number of shipyears on each route.

$$\text{shipyears} = \text{shipyears per voyage} * \# \text{ of voyages}$$

Thus the total shipyears on each route for each shiptype is calculated, which is to say the total number of active ships needed to carry the cargo during the specific years on each route.

At this point, the shipyears, voyages and forecasted capacity are adjusted by multiplying the reallocation factor to compensate for ships loading and unloading in more than one WFFS region on a trip.

#### *Step 6*

When looking at ship movements, it is apparent that not all ships are fully loaded. A ship carrying oil from the Arabian gulf to the U.S. may return to the Arabian gulf without any cargo or in ballast to reposition itself for the next load of oil. Similarly, some ships sail on triangular routes or use

random tramping patterns. WFFS does a final "ballast adjustment" to address the different shipping patterns.

It is assumed that the patterns observed in the historical data are representative of what will occur in the future. WFFS compares historical voyages with forecasted voyages by route pairs. Each route pair consists of the inbound and outbound voyages from a specific WFFS region to a specific WFFS region. Therefore, the Northeast Coast of the U.S. outbound to Northern Europe is paired with the Northeast Coast of the U.S. inbound from Northern Europe. This pair match is made for all routes in the WFFS system. The historical ratio of shiptypes on each route pair is maintained by adding shipyears, voyages and capacity to the forecast years to maintain that ratio. For example, if for large tankers the model showed:

Base year	Arabian Gulf to U.S. Gulf Coast as 300 voyages
	U.S. Gulf Coast to Arabian Gulf as 240 voyages

Forecast year	Arabian Gulf to U.S. Gulf Coast as 600 voyages
	U.S. Gulf Coast to Arabian Gulf as 0 voyages

The forecast U.S. Gulf Coast to Arabian Gulf large tankers would be adjusted to 480 to maintain the historical ratio.

The ballast adjustment also checks for shifts in flows and limits the ballast growth in those cases. For example, if for a large container ship the model showed:

Base year	Northern Europe to NICs as 300 voyages
	NICs to Northern Europe as 200 voyages

Forecast year	Northern Europe to NICs as 400 voyages
	NICs to Northern Europe as 600 voyages

If the model merely kept the voyages in the same ratio as 1992, Northern Europe to NICs would be increased to 900 voyages. It is unlikely that this many voyages (and ships) need to be added to the route. Therefore, the model increased now back haul route voyages to equal the new fore haul route voyages.

#### Non-WFFS Structure

While WFFS covers an immense amount of trade routes, it is not exhaustive. An estimation by shiptype of shipyears, voyages, capacity and cargo carried is made annually based on actual numbers. This yields the total number of ships by shiptype and the estimated cargo carried by shiptype. The Non-WFFS portion is arrived at by subtracting out the WFFS numbers. The shipyears numbers are carried forward, making adjustments to them based on Lloyd's Register. The average cargo per ship is assumed to remain the same. The voyages and capacity for these ships are calculated by taking the average voyage per ship and capacity per ship for the WFFS ships in the base years.

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1. The first part of the document is a letter from the President of the United States to the Congress, dated January 3, 1862. It is a very important document, as it contains the President's views on the state of the Union and the progress of the war.

2. The second part of the document is a report from the Secretary of the War Department, dated January 10, 1862. It contains a detailed account of the military operations of the Army during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

3. The third part of the document is a report from the Secretary of the Navy, dated January 10, 1862. It contains a detailed account of the operations of the Navy during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

4. The fourth part of the document is a report from the Secretary of the Interior, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

5. The fifth part of the document is a report from the Secretary of the Treasury, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

6. The sixth part of the document is a report from the Secretary of the War, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

7. The seventh part of the document is a report from the Secretary of the Navy, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

8. The eighth part of the document is a report from the Secretary of the Interior, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

9. The ninth part of the document is a report from the Secretary of the Treasury, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

10. The tenth part of the document is a report from the Secretary of the War, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

11. The eleventh part of the document is a report from the Secretary of the Navy, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

12. The twelfth part of the document is a report from the Secretary of the Interior, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

13. The thirteenth part of the document is a report from the Secretary of the Treasury, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

14. The fourteenth part of the document is a report from the Secretary of the War, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

15. The fifteenth part of the document is a report from the Secretary of the Navy, dated January 10, 1862. It contains a detailed account of the operations of the Department during the year 1861, and also gives a list of the names of the officers who have been promoted during the year.

**ANNEX C DRI/MCGRAW-HILL GLOBAL ECONOMIC  
PARAMETER (LONG-TERM) MODEL**

**ANNEX C**  
**DRI/MCGRAW HILL GLOBAL ECONOMIC PARAMETER (LONG-TERM)**  
**MODEL (2020 - 2050)**

The extension of a global trade model from the standard World Sea Trade Service (WSTS) forecasts will be referred to as the Parameter Model in this annex. The trade forecast model (from which WSTS is derived) ordinarily covers trade and macroeconomic information from 1980 through 2010. This time horizon is typically long enough to understand trends in trade and transportation demand but not sufficiently long to properly address infrastructure issues. To address infrastructure issues, the time horizon is extended more than 50 years, resulting in the need for the long term model. There are two elements that are modeled separately in the DRI parameter approach:

- the changing economic environment including the structural adaptation of economies from those that begin largely driven by goods production to those which are dominated by growing service endeavors;
- a commodity or industry-group specific trade model that takes into account structural parameters and long-term patterns of growth.

Like other DRI trade models, this model reflects the cross-country pattern following a "Stage of Economic Development" model of economic and trade growth. As the rest of the world matures, changing productive abilities and requirements will impact demand. While developed using a large, multi-country sample of trade and economic data, a simplified structural form of the equations is used to capture the "long term" growth:

- National wealth, as measured by per capita personal consumption expenditures
- Market size, as measured by population and share of population that is located in urban, rather than rural areas.
- Industrial structure, as measured by the relative share of manufacturing or services in total output

This model incorporates the full range of the WSTS detail -- the 40 WSTS commodities and the 38 partner regions. The forecast output from this model will cover the period 2020 to 2050 in ten year increments.

Any extension of economic data fifty years ahead is prone to a number of problems -- especially related to the availability of technology. The difference in technology available in 1935 and 1995 is telling. In 1935, in the midst of worldwide depression, unemployment stood at close to 25% throughout the Western world. The production of automobiles in 1935 was roughly 300,000 cars per year equating to about 10 days' worth of production in 1995. The economy in 1935 was concentrated in manufacturing and agriculture with services playing a less important role. The technology was vacuum tubes, computers had not been invented, and communications were slow -- no satellite dishes, no aircraft that could cover the distance across the Atlantic much less the Pacific without refueling several

times. Travel involved slow moving seaplanes and ocean liners. In short, the world was a quite different place than it is today. It was insular where we are international today. The dominant unit of political and economic power was the nation state and the predominant business unit was organized around supporting the nation's objectives, not those of the global economy. Thus, it is not a simple matter to extrapolate the future from even the past trends.

While the WSTS system draws on DRI's macroeconomic forecasts, the parameter model extends the macroeconomic outlook far into the future using a more structural model. As indicated above, very long term economic theory suggests that growth depends on the pace of technological change that impacts labor productivity and the overall growth in the labor force as measured through population growth. This world view ignores short term fluctuations that are caused by budgetary adjustments or external shocks (oil shocks, earthquakes, mistakes of political and economic judgment, wars, famines, droughts, etc. ) Growth in technology and embodied learning depend upon the emerging economic structure that is the mix between hard and soft type products (goods and services).

### *Economic Structure*

Economic structure involves individual choices. The American economy, as a case in point, moved from a largely agrarian society in the 18th and early 19th century to an industrial society in the mid-19th to early 20th century. It finally evolved to today's service economy. Even within this service economy, there are changes that are pushing services from the distribution of goods and towards the social welfare of individuals. Where the service economy may have started with the concentration in wholesale and retail trades, it has shifted towards the provision of business and individual services and of late to services that can be considered to be community or health related, i.e., education, medical, and community related (including police, prisons, and the expanding need for courts of law). Each of these "sectors" is associated with a general coefficient of efficiency.

The shifts that occurred in an economy as it moved through this structural change occur because efficiency gains are always being appropriated by the less efficient sectors. This is the iron rule of social and economic change that predates modern economic thinking. Even in the very earliest and most primitive of societies these gains have been taken through commerce. The shift from hunters and gatherers to agricultural communities is the only exception to this general rule. This change was dictated by the inefficiency of the latter and the greater efficiency from the point of both production of food and stability of community provided by the later. After this transition, successive waves of economic structures tended to take value-added from improving efficiencies in the preceding economies. So, less efficient slash and burn gave way to crop rotation and composting, farmers' surplus production could be sold to the emerging class of craftsmen through the auspices of traveling merchants. Efficiency of shopkeepers and crafts were taken by bankers and governments (royalty in the early period and parliamentary governments in

the latter). Each provided something that the other lacked. Bankers created mediums of exchange and stores of value, while governments provided rules and protection from threats. This transition from one type of economic leader to another has continued to this day. Efficiency in agricultural production that forced 90% of the population from earning a livelihood from the land to producing manufactured goods and services in the cities was first taken by manufacturing. Manufacturing efficiency has been appropriated by services. And now, the efficiency of agricultural, manufacturing, and services are being appropriated by social welfare and health expenditures.

To effectively develop a model that extends the economic timeline, models need to be developed that measure how the type of economic structures described in the paragraph above change over time. The resulting macroeconomic model is solved simultaneously yielding economic concepts that can be applied to the individual products traded internationally. Because there is a need to make this system fully endogenous, (i.e., not dependent on any assumptions other than those embodied within the relationships among the variables estimated econometrically but reflective of the broader sweep of historical change in economic growth that occurs), these parameters are based on the cross-country model that reflects the stages of economic growth. No single country's factors are reflected in the model's coefficients, but rather the coefficients reflect the "common" framework through which all countries will pass on their way from poor to rich. Even the rate of population growth can be made endogenous. There is a strong negative relationship between the rate of economic growth and the level of income per capita and the rate of population expansion.

### *The Long-Term Parameter Model*

The long-term forecast depends critically on population growth. Once population growth rates are determined through simultaneous models of output growth, they are used in a parameter version of the trade (WSTS) model which depends upon calculated point elasticities. Growth parameters for each product, both imports and exports, are applied to the trade figures from 2010, the last year of the WSTS forecast and the last year available for the macroeconomic forecasts. Export shares depend on both the reporter countries' growth path and on the growth projected for competitors. Exports, however, are derived from export shares by partner market among the 33 reporters and on the rate of import demand in the buying market.

$M_{ijkt} = (1 + (G_{it} \times E_{jk}))^{**10} \times M_{ijkt-1}$ , where

I = reporter

j = partner region

k = product

t = time at ten year intervals, starting in 2010

M = imports

G = Vector of Compound Growth Rates

for Macroeconomic Variables (10 year intervals)  
E = Vector of elasticities for macroeconomic variables.

The above equation is based on growth elasticities that are raised to the 10th power, which expands the last year's imports to a point that is ten years later. Elasticities are derived from econometric models for individual products and regions. As in the primary trade models, the pooled cross sectional time series structure is applied across all reporters. Unlike the trade models, the data set used is not only the historical period but also the forecast interval. The coefficients reflect the long-term view of the general trade model. The parameters estimated are then used to develop growth estimates.

To insure stability, it is assumed that the import demand of a reporter country from a partner region is the critical determinant of export growth. Export market share, however, varies as countries specialize. Relative export growth rates determine export market shares. Actual levels of exports depend upon a combination of import demand growth for the importing region and the projected export share. As a final step in the process, the rate of growth across all the reporter-partner combinations coming from the import direction and from the export direction are averaged. The net result is a consistent, global forecast for trade for each commodity group.

#### *Worldwide Output in the Very Long Term*

The model projects worldwide output to grow at a generally sustained rate of over 3 percent for the next six decades. It is important to note that this comes in the midst of steady decline in the real rate of growth of individual economies over time. What we are observing in this upward growth trend in real output is a shift in the weight attributed to the faster growing, but population rich nations of the "third world" toward "first world" status. So far, this long theorized "narrowing" of the gap between rich and poor has not taken place. However, within the confines of this structural modeling system, it is possible for this to take place. Thus Asia's share of the worldwide output increases dramatically. The general trends embodied in this model are likely to be sustained with the share of Asia and Latin America growing in importance as the more advanced market economies slow their economies' growth toward rates consistent with their population growth.

Driving this growth is a steady shift in the share of output across different industrial and service industries. Looking at the world economy, we can see this in the steady movement from manufacturing into services. In 1990 about 33% of total worldwide output was produced by manufacturing sectors, by 2050 this share is expected to be only about 22%. Simultaneously, the share accounted for by finance, insurance, business services will increase from about 16% to 31% and for community and personal services from 12% to 20%. Transport and communications -- serving different industries -- increases from 6% to 8%, while wholesale and retail trade declines slightly from 15% to 8%.

#### *Commodity Trade Patterns*

The long term framework model is used to drive more detailed commodity models, developed from the World Sea Trade Model (see Annex A) baseline simulations. These models are generally consistent in form to the models developed for the on going forecasts but are estimated across the entire time period and thus are based on both historical and future patterns of trade as defined by the World Trade model scenario. The rate of growth for imports and exports is thus defined by the elasticities for the factors included in these models. Only price terms are excluded and it is assumed that relative factor prices do not change in the long term. This is a reasonable assumption given uncertainty about future prices charged and future exchange rates.

#### United States Imports from the World – Growth Rates

Product Group	1990	2000	2010	2020	2030	2040	2050
Agriculture	2.8	4.2		6.2	2.9	3.1	3.3
Raw Materials	3	5	3	3.2	0.8	1.3	1.5
Energy	1.9	4.5	2.2	3.4	3.6	3.6	3.4
Chemicals	10	7.5	3.8	3.9	2.2	3.2	3.3
Intermed. Mfg.	4.4	6.6	3.2	5.2	3.2	3	3
Non-electric Eq.	8.1	6.1	3.2	3.2	3.1	3.5	3.5
Electrical	12.1	6.5	2.1	3.5	1.5	1.4	0.6
Electronics	16.8	10	4	3.6	1.7	2.1	2.4
Autos & Parts	7.6	5.8	3.2	0.5	0.8	2.2	3.1
Other Transport	8.7	7.1	5.5	6.7	3.5	3.8	3.7
Consumer	9.7	7.4	3.1	5.9	3.7	4.6	4.2
Total	7.1	6.7	3.4	4.2	2.8	3.4	3.4

#### United States Imports from the World – Market Distribution

Product Group	1990	2000	2010	2020	2030	2040	2050
Agriculture	5.8	4.6	4.5	5.4	5.5	5.3	5.3
Raw Materials	3.9	3.4	3.3	3	2.4	2	1.6
Energy	13.3	10.8	9.7	8.9	9.7	9.9	9.8
Chemicals	3.6	3.9	4.1	4	3.7	3.7	3.7
Intermed. Mfg.	10.1	10.1	9.9	10.8	11.3	10.9	10.5
Non-electric Eq.	6.1	5.8	5.7	5.2	5.4	5.4	5.5
Electrical	2.6	2.6	2.3	2.1	1.9	1.6	1.2
Electronics	12.4	16.8	17.8	16.8	15.2	13.4	12.1
Autos & Parts	14.3	13.1	13	9	7.4	6.7	6.5
Other Transport	4.5	4.7	5.7	7.3	7.8	8.2	8.5
Consumer	20.1	21.5	21	24.7	27	30.4	33
Total	100	100	100	100	100	100	100

### United States Exports to the World -- Growth Rates

Product Group	1990	2000	2010	2020	2030	2040	2050
Agriculture	0.9	4.3	4.6	3.9	1.8	2	2.4
Raw Materials	0.6	1.8	4.4	3.3	0.2	1.9	2.7
Energy	3.4	0.5	0	8.2	4.8	5.1	4.6
Chemicals	2.7	5.6	4.6	4.9	3.7	3.9	3.9
Intermed. Mfg.	0	5.4	4.5	4.6	3.9	3.7	3.6
Non-electric Eq.	0.8	4.9	5.3	5.3	4.3	4.3	4
Electrical	7.6	6.2	5.7	3.9	4.2	3.7	3.4
Electronics	8.2	7.8	5.9	4.6	3	3.2	3.6
Autos & Parts	2.4	8.7	6.9	1.3	3.1	3.9	3.6
Other Transport	0.3	3.7	5.8	5.6	3.8	4.5	3.8
Consumer	3.2	8.3	6.4	6.7	4.5	4.4	4.2
Total	2.7	5.7	5.4	4.7	3.5	3.8	3.7

### United States Exports to the World -- Market Distribution

Product Group	1990	2000	2010	2020	2030	2040	2050
Agriculture	11.2	9.7	9	8.4	7.1	6	5.3
Raw Materials	7.3	5	4.5	4	2.9	2.4	2.1
Energy	3.2	1.9	1.2	1.6	1.8	2.1	2.2
Chemicals	8.2	8.1	7.5	7.7	7.8	7.9	8
Intermed. Mfg.	7.5	7.3	6.7	6.6	6.8	6.8	6.7
Non-electric Eq.	9.3	8.6	8.5	9	9.8	10.2	10.5
Electrical	2.5	2.6	2.7	2.5	2.7	2.7	2.6
Electronics	16.8	20.4	21.2	21.1	20	18.9	18.6
Autos & Parts	8.5	11.3	13	9.3	9	9.1	9
Other Transport	12	9.9	10.3	11.2	11.6	12.5	12.6
Consumer	9.6	12.3	13.5	16.3	18	19.1	20
Total	100	100	100	100	100	100	100

**ANNEX D BALTIMORE MARITIME EXCHANGE PCEXPRESS  
DATABASE**

name and date. This structure also allows for the analysis of point-to-point summaries by selecting on certain fields and using counts of the results. Individual fields (variables) are as follows:

1. Record type -- inbound, anchorage, outbound
2. Vessel name
3. Date
4. Route (inbound and outbound) This is either Cape Henry or the Chesapeake-Delaware Canal.
5. Draft feet and draft inches are combined in a decimal draft variable. This is filled in for most inbound and outbound records but only rarely in the anchorage records. Anchorage drafts could probably be derived from copying the appropriate inbound data.
6. Inbound anchorage indicates. There are three fields showing if the inbound move is going to anchor. (DOA -- Dock on Arrival) is Y if this is the case. The great majority of inbound records (5,884 of 6,869 or 86%) are DOA. The other two fields are TPO (Take Pilot Off) or ANCHOR, which indicate that the ship is anchoring.
7. Berth. This indicates the ultimate berth for a DOA inbound movement, where the ship will be berthed when cleared for an anchorage record, and where the ship came from for an outbound record. This may be different from the inbound record. Keep in mind that many vessels move around within the port, may come into one berth, unload or load, and then move to another berth, unload and load and then leave. There is no data in the BME data base on such movements other than the inbound or outbound berth.
8. There is a variety of other data in the BME files that is not included in the pcExpress database. This includes tug information, flag of ship, agents, various time fields, comments, etc. This information can be read in with little additional effort.

#### *Description of Data Edits for Baltimore Maritime Exchange*

DRI/McGraw-Hill analysts thoroughly studied the data from BME. DRI recognized that, for purposes of cargo analysis, the BME data could be refined to more accurately reflect the movement of goods to and from the Port of Baltimore.

From the perspective of analyzing cargo, DRI is primarily interested in the movements of goods between distinct ports. The BME data, however, accounts for vessel movements within the Port of Baltimore. Between trips into and out of the port, vessels often travel within the port. Although this intra-port travel constitutes vessel movements within the Port of Baltimore, it does not account for the movements of goods between two different ports. Furthermore, the BME data may count vessels that rest at the port overnight twice. This inclusion of intra-port movements and the double counting of overnight vessels would distort the actual goods transportation between ports.

In most cases, duplicate entries were recorded by BME in between a vessel's anchorage and berth, and then during its movement out to sea. To avoid the double-counting of voyages, the DRI project team completed a comprehensive search for duplicate records within the BME data. Records that appeared twice in the BME data were only desired once in DRI's study. DRI located duplicate records by identifying those vessel calls when a vessel name appeared twice on the same date. These records were defined by DRI as repetitious and were subsequently deleted from the database.

DRI edited the Baltimore Maritime Exchange data for its analysis of trade at the Port of Baltimore.